Sproul Observatory Publications

No. 4

DETERMINATION OF THE PARALLAXES OF FIFTY STARS, AND DESCRIPTION OF THE INSTRUMENTS AND OF THE METHODS EMPLOYED

By
JOHN A. MILLER

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INTRODUCTION.

THE major part of the observing energy of the staff of the Sproul Observatory has for some time been devoted to the determination of Stellar Parallax. I have given in the following pages a brief description of the instruments used, the methods of observing and reduction that have been employed, and the results, together with the data of observation and measurement, for fifty stars.

These results have been obtained through the efforts of several persons. The work has been prosecuted according to plans outlined by the writer. Associated with him at various times have been Dr. Samuel G. Barton, Hannah B. Steele, John H. Pitman, and the Reverend Walter A. Matos. Doctor Barton, Mr. Pitman, and the writer have given during the time the work was in progress the major part of their efforts to other college duties, each having had a comparatively heavy teaching roster. Miss Steele also had some other college duties.

Doctor Barton was at the observatory two years, 1911–1913, in the beginning, and had a very considerable part in the preliminary adjustments of the telescope and in the determination and elimination of the errors of the telescope and measuring engine. Mr. Pitman came to the observatory in 1913, when Doctor Barton went to the Flower Observatory, and has been here ever since. In addition to the routine of making exposures and measures, he has had a large part in the selection of the observing program and methods of procedure. Miss Steele has spent three years here, and during that time has reduced practically all measures, has made many of the exposures and measured many of the plates. Doctor Matos has been a voluntary observer for a little more than a year. I have endeavored in the following pages to give as

nearly as can be done due credit for each specific piece of work, using the proper initials in the body of the text. We have consulted freely and frankly, and changes that have been made in our methods at any time were likely to result from the suggestion of any one of us. It is a pleasure to acknowledge the whole-hearted coöperation of every one working at the problem.

PART I.

The Telescope and Accessories.

The Telescope: Its Objective.—The telescope used in making the observations is a visual refractor of 24 inches aperture and approximately 433 inches focal length. It is the major instrument of the equipment given to Swarthmore College by William Cameron Sproul, a graduate of the college of the class of 1891.

In May, 1907, the college entered into a contract with the John A. Brashear Company, Limited, to furnish the entire equipment provided for by Mr. Sproul. The 24-inch telescope was completed and mounted in its observatory in December, 1911, the long delay being due to a somewhat tedious wait of four years for disks out of which the lens could be constructed. The order for these disks was placed by the Brashear Company early in 1907 with the Parra-Mantois Cie., who, in August, 1909, delivered a crown disk and would have, but for an unfortunate accident, delivered a flint disk the same year. Subsequently Schott and Gennossen, of Jena, also undertook the manufacture for us of a set of 24-inch disks. Both firms produced several flint disks which were either broken in annealing or were imperfect because of striæ. Finally, in February, 1911, Schott and Genossen delivered a flint disk; accordingly, the objective is made of a crown disk by the Parra-Mantois Cie., and a flint disk made by Schott and Gennossen. Of the quality of these disks Mr. McDowell says that every optical test shows both these disks to be as nearly perfect as any he has ever examined.

Soon after the telescope was mounted Prof. R. W. Marriott and myself applied to the objective the method of extra focal images devised by Hartmann. We covered the objective with a screen containing 44 circular holes 33 mm. in diameter. The centres of these holes were on nine different zones. With this

screen we photographed Capella when it was near the meridian, photographing through a yellow ray filter, made by Wallace in accordance with the color curve of the objective. We used Cramer instantaneous isochromatic plates. These plates, when measured and reduced, showed the presence of certain small astigmatic errors that Mr. McDowell asserted were not present in the objective when it was in the optical room. He surmised that it was due to the pressure of a spring used to prevent the objective from sliding in its cell. At Mr. McDowell's suggestion we repeated the test, after reducing the pressure of this spring, using Arcturus instead of Capella, and using a screen containing 78 circular holes, distributed on ten zones. Notwithstanding the fact that Capella was photographed with the telescope east and Arcturus with the telescope west of the meridian, that one of them was north and the other south of the zenith, that the temperature was low when Capella was photographed and high when Arcturus was photographed, both tests showed qualitatively practically the same astigmatic errors, though they were smaller in the case of Arcturus than with Capella. These errors are not large: in fact, they are very small. With the values thus obtained we computed Hartmann's Characteristic T by which he measures the quality of an objective. Hartmann said, when he devised this method of testing objectives, that if T turned out to be less than 0.5, the objective is "preëminently excellent."[1] The result which we obtained for the Sproul objective gives $T = 0.27$.

In 1913[2] we decided to repeat the Hartmann test of the objective, after having again reduced the pressure of the spring referred to above; and in order to cover the lens very completely, we decided to use three screens.

Screen No. 1 contained 32 holes, arranged on eight zones; the radii of the zones on this screen were 2, 5, 6.5, 8, 8.75, 9.5, 10.25, and 11 inches, respectively.

Screen No. 2 contained 36 holes, arranged on nine zones; the

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[1] Hartmann: *Zeitschrift für Instrumentenkunde,* vol. 24.
Plaskett: *Astrophysical Journal,* vol. 25.
Fox: *Ibid.,* vol. 27.
Hartmann: *Pub. des Astrophysikalischen Obs. zu Potsdam,* Nr. 46.

[2] For details of this test see Sproul Observatory Publications No. 3; THE JOURNAL OF THE FRANKLIN INSTITUTE, vol. clxxviii, No. 4, October, 1914.

radii of these zones were 2.25, 4.25, 5.25, 7.25, 8.375, 9.175, 9.875, 10.625, and 11.375 inches.

Screen No. 3 contained 14 holes, arranged on seven zones; the radii of these zones were 1.5, 3, 3.75, 4.5, 5.875, and 7.625 inches.

On January 9, 1913, Capella, when near the meridian, was photographed through each of these screens in the following manner:

Each screen was used in two positions. Screen No. 1 was set with a given diameter parallel to the equator and five exposures were made. It was then rotated through 45 degrees about an axis through the centre of the lens perpendicular to the plane of the screen and five additional exposures made on another plate. Screen No. 1 was then removed and Screen No. 2 placed over the lens and, five exposures through it having been made, it was turned 45 degrees and five additional exposures made on another plate. Screen No. 2 was then removed and Screen No. 3 put in its place, and, five exposures having been made, it was turned through 90 degrees and five exposures made on another plate. Integrating these results, this was equivalent to photographing through a single screen containing 164 holes, arranged on 24 zones. There were eight holes on each of 17 zones and four holes on each of seven zones. These holes were distributed on diameters of the lens making angles of 22½ degrees with each other. Fig. 1 shows this integrated screen.

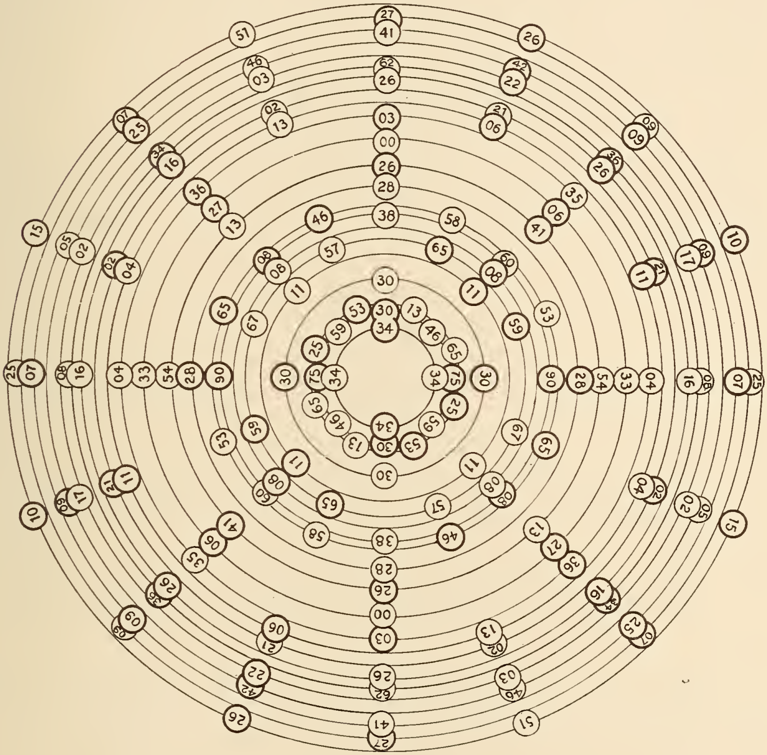
It will be noted (see Fig. 1) that some of the holes partially overlap each other. The numbers in the holes show the number of *hundredths of a millimetre* that that particular part of the lens was in error. The heavy circles represent the positions in which the lens focused too short, and the light circles where it focused too long.

We used every precaution possible to eliminate local errors. The screens had been in the dome-room for several hours previous to making the photographs in order that they might be of the same temperature as the lens. The screens were constructed carefully and oriented so that the centre of the screen was superimposed on the centre of the objective. Each set of five exposures was made on the same plate. The first exposure was in the centre of the plate and the remaining four grouped symmetrically around the centre one, displaced just enough so that their patterns did not overlap each other. The plates were then measured on a measuring engine, one set each by Prof. S. G.

Barton, Professor Marriott, and myself. The agreements between the measures are satisfactorily accordant.

The curves in Fig. 2 are the curves of zonal error; the abscissa of any point is the radius of a zone, and the corresponding ordinate is the focal length of that zone diminished by a constant and multiplied by 25, so that the difference of any two ordinates

Fig. 1.



is 25 times the difference in the focal length of the two corresponding zones; that is, the errors are magnified 25 times. The actual difference between the greatest and least focal length of any two zones is less than 1.1 mm. The curves *EF*, *CD*, and *AB* are respectively the graphs of the measures made by Miller and Marriott, and the mean of those measures. Barton did not measure one of the plates in the series. For this reason his measures were not included in the computation of the zonal error.

Hartmann's characteristic quantity, "T," was computed by his formula:

$$T = \frac{100{,}000}{F}\,\frac{\Sigma rd}{\Sigma r} = \frac{200{,}000 \sum_{n=1}^{24} r^2 (A_n - A_0)}{F^2 \Sigma r},$$

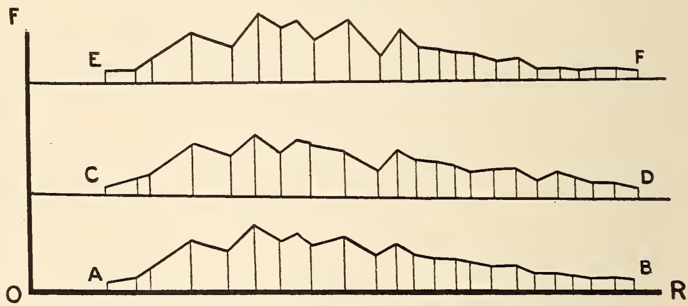
where F is the focal length of the objective, r the radius of a zone, d the diameter of a circle of confusion, A_n the focal distance of the zone n, and A_0 the quantity determined by the Hartmann formula.

We found:

$T = .068$ from Marriott's measures, and
$T = .086$ from Miller's measures.

We also computed the diameters of the circles of confusion for each of the 24 zones. Expressed in terms of hundred thousandths of the focal length, the diameter of the maximum circle of confusion was 0.143.

FIG. 2.



The curve of zonal error. The error is magnified 25 times.

These tests show that the lens is an excellent one, the focal discrepancies, the diameters of the circles of confusion, and T, the weighted diameter of confusion, all being extremely small.

The mounting of the telescope, also by the Brashear Company, is described at some length in Sproul Observatory Publication No. 2 and in *Popular Astronomy*, vol. xxi, No. 5, May, 1913.

Double-slide Plate Holder.—We are determining stellar parallaxes by means of photography, following with very slight modifications, which are pointed out later, the method described in the *Astrophysical Journal*, vols. 32, 33, and 34, by Schlesinger.

The telescope is provided with a double-slide plate holder es-

sentially the same as that designed by Ritchey, and described by him in the *Astrophysical Journal,* vol. 12, p. 355. A screw placed convenient to the operator serves to move the plate holder in right ascension, and one at right angles to it to move it in declination. The screws originally provided were somewhat unsatisfactory. To adjust them so that there was no lost motion and so that the operator could move them easily was a tedious cut-and-try process. It seemed also that the wearing of the material and the changes of temperature of the instrument easily led to maladjustment, the result being that the operator often worked when the adjustment was not perfect, and, in the beginning at least, these screws contributed more than their share to the making of bad images. We afterward had these screws replaced by others designed and made by R. Pietsch and Company, 830 Race Street, Philadelphia. They are made as follows: The stem on which the screw is cut is of stiff, hard steel. The end of the stem farthest from the grip by which the observer turns the screw terminates in a sphere which is enclosed in a spherical bearing, which is concentric with the sphere on the end of the stem. This spherical bearing can be adjusted by means of a nut so that the sphere rotates easily in its bearing with no perceptible lost motion. This bearing is fastened to the box carrying the plate holder. The screw passes through a cylindrical nut, split along one element of the cylinder, which is fastened to the frame of the telescope. Approximately perfect adjustment is easily made by means of a screw through a flange containing the element, and when once made is reasonably permanent.

Ray Filters.—Since the objective is a visual one, we use a ray filter [3] transparent to those rays for which the objective is focused best. We use one of two filters. One of these was made by Wallace and consists of a piece of worked glass covered with a thin gelatin film stained with a dye. In order to protect the film, the first glass plate is cemented to another plate of worked glass. The filter absorbs the rays that it should, but the surfaces of it are not optically plane nor are they exactly parallel. Computations show that a star image might be displaced 0.0008 mm., due to the fact that the surfaces are not plane. This error is smaller than the error of bisection, and yet it seemed unwise to deliberately run the chance of introducing it. Accordingly, Petitdidier, at my re-

[3] Ritchey: *Astrophysical Journal,* vol. 12, pp. 353, 354.

quest, constructed for us a filter from a single slab of optical glass by Schott and Gennossen which is transparent to practically the same rays as the Wallace filter is. The faces of this filter are parallel planes. We are using plates 5 by 7 inches. It was impossible to secure a slab as large as that which was homogeneous in color and structure. This filter is 4¾ by 5¼ inches. The quality of the images made through the two filters as seen through the microscope of the measuring engine is about the same. If it happens that because of its size the Wallace filter gives a more desirable field of comparison stars, we use that filter, otherwise we use the Petitdidier filter. The Wallace filter is always put in the plate holder in the same way, and, since the star images fall at the same place on the filter for all the plates of a given star, it is quite unlikely that any error is introduced by its use. All the plates for any one star are taken with the same filter. We compared the filters by examining the residuals found in reducing the measures. From 259 plates the Wallace filter gave an average residual of 0.0064 quarter millimetre. From 106 plates the Petitdidier filter gave an average of 0.0062 quarter millimetre: from which it would appear that one filter is as good as the other.

Plates.

After some experimentation with various makes of plates, we found the Cramer instantaneous isochromatic plates and the Hammer orthochromatic plates best suited to our purpose. Most of our negatives have been made on Cramer plates, and we are using those at present.

The Occulting Disk: The Optical Centre.

It is desirable to have the images of all the stars that are to be measured nearly the same size. In order to reduce the images of the parallax star to the average size of the comparison stars we have adopted the occulting device designed by Schlesinger and described by him in the *Astrophysical Journal,* vol. 32, pp. 384, 385. This occulter is driven by a little toy motor which is fastened to the double-slide plate holder.

We have used this device whenever the parallax star is brighter than the eighth magnitude. We have reduced stars as bright as Procyon to that of a star of ninth magnitude, the width of the

sector opening in that case being about $\frac{1}{100}$ of the entire circumference. It is possible that in the case of a very narrow opening, such as is necessary for Procyon or even for stars of the third magnitude, diffraction errors may enter. The entire matter should be investigated. So far as residuals indicate in the reduction of the plates, we have not been able to discover any.

The optical centre of a photograph has been defined as the foot of a perpendicular let fall on the photographic plate from the centre of the objective. At the very beginning of our work we determined the position of this optical centre of the photograph, using the method described by Schlesinger.[4] We found that the plane of the plate was not exactly perpendicular to the optical axis of the objective and that the error was in the construction of the metal plate holder. This error was corrected and the optical centre of the photograph redetermined and was found to be 0.34 inch north and 0.05 inch east of the geometrical centre of the plate. The optical centre was redetermined by Mr. Pitman just recently and found to coincide with the position found three years ago.

The Exposures.

Our ideal is to expose 12 plates—three plates on each of four epochs—on any one region. We usually make three exposures on each plate and develop it at once. Six of these plates are exposed at the time of negative parallactic displacement and six at the time of positive parallactic displacement. This has been our ideal. Occasionally it is possible to secure only two exposures on a plate. In a few instances five plates have been made of a field when the parallactic displacement is negative (or positive) and seven plates when the parallactic displacement is positive (or negative), and occasionally we have more than 12 plates, and in a few instances only ten plates have been measured. These cases are pointed out in the detailed discussion of each star. We have (see the discussions of Kapteyn, Schlesinger, Russell, and others) exposed only when the star is near the meridian; never when the hour angle is more than one and one-half hours; at the *end* of the exposure; and usually the extreme hour angle is less than one hour. All in all, we are a little more likely to have western hour angles in our evening observations and eastern hour angles in our morning observations. With hour angles such as we are using the differential refraction does not cause

[4] *Astrophysical Journal,* vol. 32, p. 376.

appreciable errors, and our residuals do not seem to depend upon whether the hour angle is east or west.

The times of exposures vary from three minutes to twenty minutes, the average exposure being about nine minutes. Our work at the telescope is as follows: On an observing card we have a chart of the region of which the parallax star is the centre; its coördinates and its magnitude; the angle that the occulter should be opened; the setting of the eye-piece for the guiding star; and the time of the exposure. The parallax star is brought to the middle of the field by means of a visual eye-piece, fastened to a metal plate which is put in a plate holder in the place to be occupied by the photographic plate. All exposures have been made with the telescope on the west side of the pier.

The Program.

The program of observation was selected before the appointment of the parallax committee by the American Astronomical Society. It was found desirable, after the appointment of this committee, to modify it only slightly. At present it includes objects found in one of the following named classes. The greater emphasis is placed upon the first three classes.

1. All visual binaries whose orbits are well determined; also those visual binaries whose orbits we have reason to believe will be determined in the not too distant future.
2. Some spectroscopic binaries.
3. Some objects with large hypothetical parallax.
4. Three or four objects whose parallaxes are well determined (intended for calibration of our methods and results).
5. Some objects of large proper motion.
6. Objects whose hitherto determined parallaxes are discordant.
7. Some objects of especial interest, such as Nova Geminorum II and Barnard's "Runaway Star."

PART II.

Choice of Comparison Stars.

In the main we have chosen four or five comparison stars. Four, properly distributed, I believe to be all that are necessary. In choosing them we have had these ideals: (1) They should be arranged symmetrically about the parallax star, and (2) they should be nearly of the same magnitude, (2) being of much more

relative importance than (1). This canon has been violated in some of our earlier series, but adhered to very strictly in our later work. Our first and chief variation from the practices of observers preceding us is in our method of choice of comparison stars, and I shall now discuss it in some detail. We proceed as follows: We choose two of the best plates taken at each of three epochs (that is, six plates in all), and measure the x-coördinates of most if not all the stars on them that are about of the same brightness. The number of stars on the plate, of course, varies with the richness of the field. Some plates may have only four stars satisfying the conditions, others as many as 15. The largest number that we have measured on any one plate is 12. On an average we measure eight stars preliminary to the final choice of a field. Having measured these six plates and chosen one as a standard, we compute the orientation factors by formula (3), page 23 (which see), by which we can compute from the measured x-coördinates the x-coördinates that would have resulted if the plate had been set up exactly as the standard plate was and under the same temperature conditions. If there be n stars in this preliminary field and if $\overline{X}$ be the x-coördinate of the centre of gravity of this preliminary field of comparison stars, and X_i the x-coördinate of the ith star of the field on the oriented plate, then

$$X = \frac{\Sigma X_i}{n}$$

We now refer the stars to this centre of gravity, and write

$$X = X_i - x^i$$

Let us suppose plates have been measured at each of *four* epochs, and let us consider the ith star. Since no confusion will arise we shall not carry the designating subscript i and shall let the subscripts 1, 2, 3, 4 designate the x-coördinates of the same star at the respective epochs.

If now P be the parallax factor, μ the proper motion relative to the centre of gravity, T the time of the observation referred to an arbitrary epoch, C a constant, and π the parallax relative to the centre of gravity, we have the equations:

$$\begin{aligned}
\overline{X}_1 - X_1 &= x_1 = P_1\pi + T_1\mu + C, \\
\overline{X}_2 - X_2 &= x_2 = P_2\pi + T_2\mu + C, \\
\overline{X}_3 - X_3 &= x_3 = P_3\pi + T_3\mu + C, \\
\overline{X}_4 - X_4 &= x_4 = P_4\pi + T_4\mu + C.
\end{aligned}$$

We can determine π and μ from these equations; for our immediate purposes it is sufficiently accurate to make the assumption $P_1 = P_3$ and $P_2 = P_4$.

$$\therefore x_3 - x_1 = (T_3 - T_1)\mu,$$

and

$$x_2 - x_1 = (P_2 - P_1)\pi + (T_2 - T_1)\mu.$$

These equations determine π and μ of this particular star relative to the centre of gravity of this preliminary field. We treat each of the stars in a similar manner. This preliminary field is originally so chosen that several groupings are possible, each of which permits a choice of a final field that satisfies the requirements for symmetry and magnitude. In choosing our final field we in general reject those stars that show large positive parallaxes and include those that show large negative parallaxes. It seldom happens that a preliminary field of eight stars contains more than one or two that would be excluded from the final field by this method, nor more than about the same number that would certainly be included.

In order to show the relation a little more readily to the eye, we graph the results as follows: We plot as many points on millimetre paper as there are epochs. To fix the ideas, let us suppose there are four epochs in the order that the eastern and the western parallactic displacements alternate. We then plot 4 points, *O, A, B, C* (see Fig. 3), whose abscissæ and ordinates are all, respectively, *o, o*; $T_2 - T_1$, $X_2 - X_1$; $T_3 - T_1$, $X_3 - X_1$; $T_4 - T_1$, $X_4 - X_1$. It is evident that the ordinate of *B* is the proper motion of this star relative to the centre of gravity; and that the part of the ordinate of *A* included between *A* and a line joining *O* and *B* represents approximately double the parallactic displacement at that epoch, actually *AD* represents $(P_2 - P_1)\pi$. These are plotted in terms of thousandths of a quarter millimetre, and when I speak in what immediately follows of a parallax or a proper motion of ten I mean that the displacement is 0.010 quarter millimetre. We use the fourth epoch (if there be one) as a check. It is evident that in general the line joining *OB* should be parallel, or nearly so, to the one joining *A* and *C*, and that the line joining *O* and *A* should be parallel to the line joining *B* and *C*. The graph (or the equations) then give two determinations of the parallax and of the proper motion, and hence a chance for comparison and check. We have used four epochs whenever the

observations were available. Several questions arise in connection with this practice. I shall discuss three of them.

1. Are the parallaxes of the comparison stars determined in this way and which are very small quantities real, or are they simply the unavoidable errors of measurement?

In my judgment, the answer to this question is that they are real, but not unqualifiedly so, for reasons I shall now state. Or, better stated, perhaps the parallaxes thus found, in most instances are so small that they are non-committal, but there are many in-

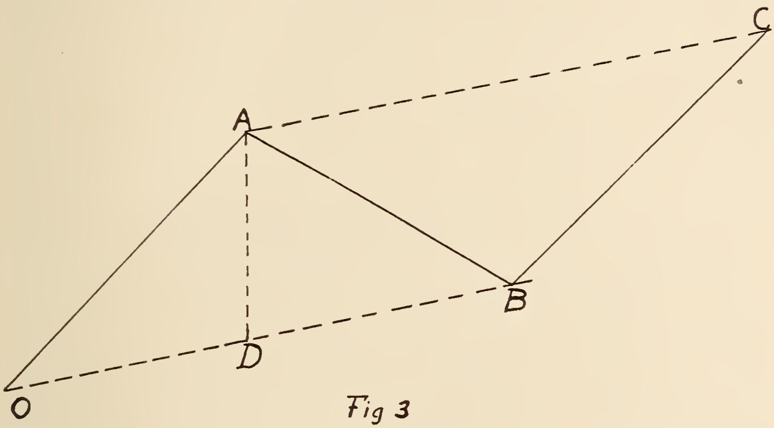


Fig 3

stances in which they are certainly qualitatively dependable. We have discussed in all 25 fields in this way. The parallax of ten of these 25 stars had been determined before we devised this method, all but one of the ten being visual binaries whose orbits were well determined. The average number of comparison stars per field for this ten was 4.5. *Two* of these ten fields showed that in each we had chosen for a comparison star one that had considerable parallax. In each case this comparison star was rejected and the parallax recomputed. The remaining 15 preliminary fields had an average of eight stars in them: the largest number of stars in any one field was eleven and the smallest number five. Nine of these fields were graphed at four epochs. The points *O, A, B,* and *C* were plotted as before described. For all those stars, for which the line joining two evening observations is parallel to a line joining two morning observations—and this is a severe test—we have said the graph checked, but if it failed in any particular we counted it as "not checked." It

might happen that two or three or four or more stars checked and the remainder did not. In the case of fields when one plate only at each epoch was measured there were as many cases that did not check as there were that did check. In the cases that all the stars of the preliminary field were measured on *two* plates at each

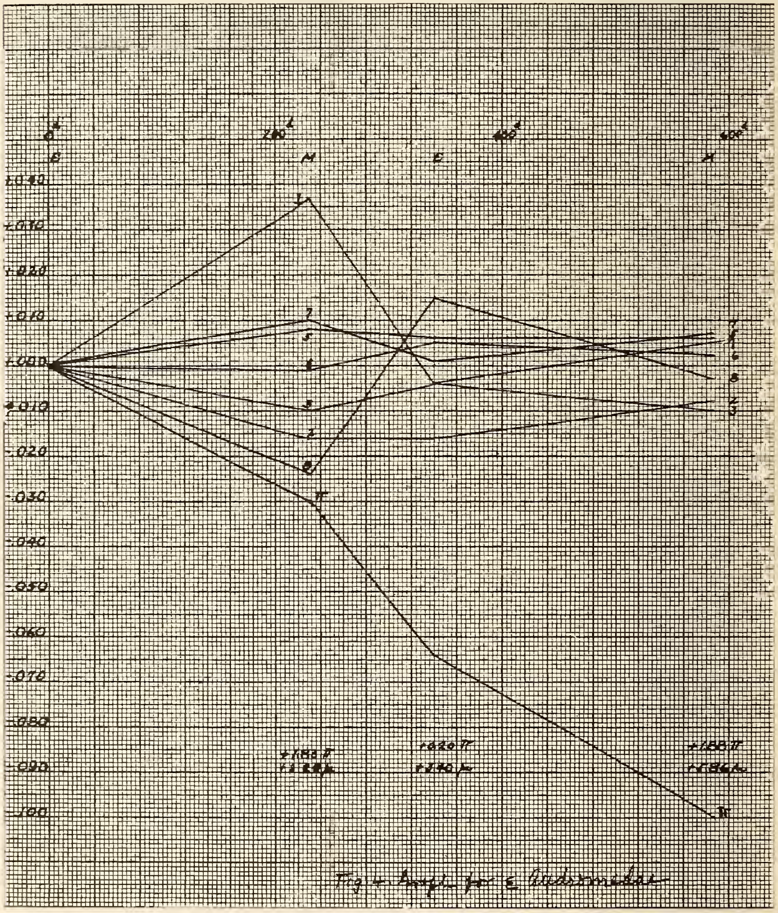


FIG. 4.

epoch the number of "checks" to that of "not checked" was in the ratio of 11 to 5. Judging from these data, we should conclude that one plate measured at each epoch would not tell us much. But two plates at each epoch do. But the data at present are too meagre to justify generalization. The quan-

tities x_2-x_1, x_3-x_1, as well as the parallax of the comparison stars on this graph, are given in terms of thousandths of a quarter of a millimetre and are usually too small to indicate anything.

In a field of eight stars there are seldom more than two whose parallax is large enough to be a guide. In ten fields averaging eight stars to each field there were in all twenty-two stars for which the distance *AD*, which represents roughly double the parallax of the star, was ten or greater; that of 59 was less than ten. The double parallax of six out of 81 was greater than 20. In our choice of the final field we are influenced very little by a double parallax of less than eight and not at all by one less than five.

The differences x_2-x_1 . . . used in making the graph are also usually very small. We computed the probable error for all the differences for those fields where two plates had been measured at each epoch. There were 88 differences numerically greater than ten; of these, eight differences had a probable error greater than the quantity we were seeking, and in 80 cases the probable error was less. Taking all the differences, there were about as many probable errors less as there were greater than the quantity we were seeking. The sum of all the differences was just about twice the sum of all the probable errors. The nature of the results is fairly illustrated by the case of ϵ Andromedæ measured by Miss Steele. Fig. 4 is the graph of ϵ Andromedæ and its preliminary field of comparison stars. In the table on page 16 the first row contains the number of the star on the plate; the second row the quantity x_2-x_1 for each of the stars; the third row the corresponding probable error; the fourth row the quantity x_3-x_1; the fifth row the corresponding probable error; the sixth and seventh rows the quantity x_4-x_1 and corresponding probable errors. The eighth row contains the double parallaxes of each star read from the graph of the first three epochs. The ninth row contains the double parallaxes of the same stars as read from the graph for the last three epochs. By observing the graph it will be noticed that the stars 3, 5, 6, 7, and 8 "check," and the stars 1 and 2 do not. A good illustration of the graph of the star that checks is that of No. 8 and parallax. A good illustration of that of a star which does not check is No. 2.

ϵ Andromedæ

Star No.	π	1	2	3	5	6	7	8
$x_2 - x_1$	30.0	37.0	16.0	10.0	8.0	1.0	10.0	24.0
p. e.	4.4	2.1	3.1	7.1	7.3	4.3	4.1	1.8
$x_3 - x_1$	64.0	4.0	16.0	4.0	6.0	4.0	1.0	15.0
p. e.	7.7	9.8	10.0	8.2	8.8	5.0	6.4	18.6
$x_4 - x_1$	100.0	5.0	8.0	10.0	6.0	20.0	7.0	3.0
p. e.	3.9	3.5	5.3	7.1	7.0	2.1	3.9	6.7
1.8π		+40.0	−6.0	−8.0	+4.0	−4.0	+9.0	−34.0
1.9π	+14.0	+31.0	+3.0	−6.0	0.0	−4.0	+9.0	−33.0

2. The second question is, Do we get nearer the truth in this way than we should have done had we chosen the field at random?

Suppose the parallaxes obtained for these comparison stars were due wholly to observational error. Then the effect would be to introduce a systematic error into parallax determination. For the measures of this preliminary field are just half of all the plates measured, and the rejection of any of the stars because they show a large positive parallax, and the inclusion of others because they show a large negative parallax, prejudice the determination in favor of large parallaxes. In many cases there are no large parallaxes of the comparison stars shown, and hence there is no prejudice carried by any field choice, but there are cases in which large parallaxes do appear. They are either real or due to observational errors. If they are real the large positive ones should be rejected and large negative ones included in the final field chosen; particularly is this so for the binary stars which form so large a part of our program, because the parallax enters so directly into the determination of the mass, dimensions, and luminosity of the system. If, on the other hand, these parallaxes determined in this way are spurious, and if the large positive ones are rejected and large negative ones included, the results will certainly be in error. One might free his results from this prejudice by rejecting, for the purpose of determining the parallax, the six plates used for the purpose of determining the field. This would require that six additional plates should be taken, which would increase the photographic work by 50 per cent. The computation and measurement in such cases would be double that required when the fields are chosen at random. The errors of observation arise from the error of

bisection of the images in measuring, the distortion of the film, the "guiding" error, and some other causes. The first and perhaps least influential of these could be removed from the final results by remeasuring the six plates from which the field was chosen. Perhaps this should be done. It is hard to believe, however, that errors could result in such a way as to make a graph built from four epochs "check."

3. Is all this extra work worth while?

I believe it is for the program we are carrying here; for the parallax enters so directly into the determination of the mass of a binary and the linear dimensions of its orbit, and hence it is desirable to get as nearly as possible an absolute parallax. It is true that there will be many preliminary fields from which a final field can be chosen that carries no prejudice with it because all of the parallaxes are small. But in the case of binary stars, if a comparison star shows a large positive parallax, it is better to take a field without it, and to determine the parallax from plates, not measured in choosing the final field.

A case in point is that of δ Cygni, for which we had taken more than the required number of plates. Six plates with the preliminary field of stars numbered 1, 2, 3, 6, 7, 9, and 10 showed that stars numbered 1, 3, and 9 had a rather large positive parallax, and that the stars numbered 2, 6, and 10 had a negative parallax; star numbered 7 had a very small positive parallax. We retained three of the plates from which the field was chosen and measured seven additional ones. The parallax of δ Cygni, computed with field 1, 3, 6, and 9, was found to be $0''.007 \pm 0''.019$. With the field 2, 6, 7, and 10 the parallax was found to be $0''.049 \pm 0''.008$. I have not the slightest doubt that the latter result is nearer the absolute parallax than the former. Mr. Pitman first suggested the desirability of some such method of procedure and the method that we actually use was largely due to him.

PART III.

The Measuring Engine. Methods of Reduction.

The plates are measured on an engine essentially the same in most particulars as that described by Schlesinger in the *Astrophysical Journal,* vol. 33, pp. 10 *et seq.* The machines are the same in the arrangements of the guiding ways; the microscope ways; the counter-balancing; the posts carrying the dots for

rotating the plate through 90 degrees; the manner of comparing the plate with the scale, and of bringing the film always in the same plane. They differ in the following respects: The measuring engine that we use is smaller than the one referred to above, being large enough to receive plates 5 by 7 inches—the size we use. The iron plate carrying the photographic plate is provided with a circle by means of which position angles may be set off. The circle is graduated to degrees, and may, by means of a vernier, be read to tenths of a degree. The disk carrying the position circle may be clamped to another iron disk which rotates about an axis perpendicular to its plane and the plane of the plate. This enables the operator to rotate both disks through any angle the operator desires. Stops are provided rotating them through either 90 degrees or 180 degrees. The microscope carries a micrometer the screw of which has a pitch such that four turns of the screw correspond to one millimetre (approximately) on the plate. The eye-piece is provided with a reversing prism.

The scale with which the plate is compared is 24 cm. long and is graduated to millimetres, but numbered in quarter millimetres. For example, a reading of 400 means that a mark is 100 mm. from the zero end of the scale. The scale was compared by the Bureau of Standards with the Standards of the United States. The Bureau gave the corrections that must be made to any interval in terms of microns at a temperature of 23° C. All the corrections are positive (that is, each interval is longer than its nominal length); the corrections are given to the nearest half micron, the probable errors of some of the corrections being as much as 0.6 micron. Since the scale is numbered in quarter millimetres, we multiplied the correction given by the observers of the Bureau by four in order to reduce the corrections to the same units as the mark on the scale. Table I gives the value of each interval from the zero of the scale to a given mark plus the four times the correction given by the Bureau of Standards. For example, the interval from zero to mark numbered 216 is 54 mm. + a correction of 0.0075 mm. In the table following it is recorded as 216.030.

Table I.

96.024					
120.020	260.026	400.036	540.040	680.042	820.050
124.016	264.028	404.040	544.038	684.042	824.050
128.018	268.028	408.038	548.038	688.044	828.050
132.022	272.030	412.040	552.036	692.044	832.050
136.022	276.024	416.042	556.036	696.044	836.050
140.020	280.032	420.038	560.036	700.044	840.050
144.020	284.030	424.034	564.036	704.046	
148.020	288.030	428.040	568.038	708.046	864.052
152.022	292.028	432.038	572.040	712.046	
156.024	296.030	436.038	576.040	716.044	960.056
160.022	300.032	440.040	580.042	720.044	
164.018	304.034	444.038	584.040	724.048	
168.020	308.032	448.038	588.040	728.046	
172.024	312.034	452.038	592.040	732.048	
176.024	316.036	456.040	596.040	736.042	
180.024	320.034	460.038	600.040	740.046	
184.026	324.034	464.038	604.042	744.046	
188.028	328.036	468.038	608.044	748.046	
192.028	332.032	472.036	612.040	752.046	
196.030	336.034	476.034	616.044	756.046	
200.024	340.034	480.034	620.040	760.048	
204.030	344.034	484.036	624.040	764.048	
208.034	348.032	488.040	628.036	768.048	
212.028	352.032	492.034	632.040	772.050	
216.030	356.034	496.034	636.038	776.052	
220.026	360.030	500.034	640.042	780.050	
224.030	364.030	504.036	644.040	784.050	
228.028	368.032	508.036	648.038	788.054	
232.032	372.032	512.036	652.040	792.052	
236.030	376.034	516.036	656.042	796.052	
240.030	380.034	520.036	660.044	800.052	
244.028	384.034	524.034	664.044	804.052	
248.028	388.032	528.034	668.044	808.052	
252.024	392.036	532.040	672.044	812.050	
256.028	396.038	536.034	676.042	816.050	

The Guiding Way.—In order to test the straightness of the guiding way we placed a spider's web stretched approximately straight between two plates of glass, which we fastened together. These were placed in the measuring engine so that the spider's thread was approximately parallel to the guiding way.

We measured the distance from the guiding way of various points on the thread whose positions were determined by a millimetre scale fastened to the guiding way. The plate was then turned through an angle of 180 degrees about the thread as an axis, the adjustment being such that each of the points to be measured is again opposite the same point on the guiding way that it was when it was first measured. The distance of these points from the guiding way was again measured. We then found the mean of these two distances for each point of the thread from the guiding way. Points at distances from the guiding way equal to these means should lie on a straight line. The amount of deviation is the error of the guiding way. The character of the guiding way was determined by Miss Steele and myself in 1914, and again by Mr. Pitman in 1916. The measures were only fairly accordant. But the measures of 1916 did not show that there had been any wear on the guiding way. The means of the three measures were as follows:

Table II.

Deviation of Guiding Way in Quarter Millimetres.

Side scale reading	Deviation in quarter millimetres	Side scale reading	Deviation in quarter millimetres	Side scale reading	Deviation in quarter millimetres
90	+0.002	140	−0.005	190	+0.002
95	+ 11	45	− 2	95	− 5
100	+ 7	50	− 2	200	+ 2
05	− 2	55	− 2	05	+ 3
10	+ 5	60	− 2	10	+ 7
15	− 1	65	− 2	15	− 3
20	+ 1	70	− 7	20	+ 5
25	+ 5	75	− 7	25	+ 2
30	− 1	80	− 2	30	− 1
35	+ 3	85	− 6	35	− 1

The adjustment of the posts for turning the field through 90 degrees, as well as the determination of the angle between the diagonals of the quadrilateral formed by the four posts, was determined by Dr. S. G. Barton. He used the method described by Schlesinger.

The work at the measuring engine is as follows: We have measured most of the plates parallel to the ecliptic. At the close of the exposure a trail is made on one or more of the plates of each series. The telescope is provided with an electric slow motion in right ascension which is operated at the eye end of the telescope by means of a switch. By closing this switch stars

are made to trail upon the plate. In case the star is too faint to trail it is customary to allow the driving clock to drive the telescope for a short time after it has been displaced by means of the switch. We have assumed this trail is parallel to the equator, not making corrections for its curvature, which is so small that it will not affect the parallax. One of the plates on which is the trail is set up and turned through the proper angle so that the x-coördinates are parallel to the ecliptic. The other plates are set up by making the difference in the x-coördinates between any two stars equal the corresponding difference on the first plate. The measurement is then as follows: The micrometer carries a single wire, and parallel to it a pair of wires set just wide enough apart so that if the mark on the scale is placed between them a thin strip of silver shows between the mark and either of the wires. One can set on a mark in this way with great accuracy. The star image is first bisected with the single wire with the reversing prism in a given position, then the reversing prism is turned through 90 degrees and the star bisected again. The microscope is then tilted to the scale and the double wires set on the mark with the reversing prism in the direct and in the reverse position. The microscope is then turned to the star, which is bisected again with the reversing prisms in both positions. We measure the parallax star at the beginning, then all the comparison stars, and the parallax star again at the end. We always set the double wire on the mark nearest it when the microscope is tilted to the scale, so that we never need turn the micrometer head through more than two revolutions. The part of the micrometer screw used in the measures was thoroughly tested by Miss Steele and myself. We selected two small dots of about the same size on a plate, separated from each other approximately a distance equal to one turn of the screw, and measured the distance between these points, using every part of the screw that is used in the measurements of stars. Miss Steele made three series of measurements and I made two series. We concluded that any irregularity in the screw was much less than the error of bisection.

The value of the micrometer screw is determined one or more times each day; that is, we determine how much four revolutions of the screw differ from one millimetre, and apply the necessary correction to all the measurements.

The Method of Reduction.

We reduce our measures by the "Method of Dependences," described and discussed in a most admirable way by Schlesinger.[5] For that reason much that immediately follows need not be written. I have, however, convinced myself of the validity and efficiency of the method in the very elementary way, none of which is new, discussed in the following pages. I have in the end deduced the same equations as Schlesinger did and conserved his notation. But I have reached these results in a slightly different way. This prefatory remark is by way of apology, and the reader need not read it, but may pass over immediately to equation (5).

Suppose we set up a standard plate. Take as origin on the scale the zero of the scale and a point just beneath it as the origin on the plate, and a line parallel to the ecliptic (or equator) which we suppose parallel to the scale as the x-axis. Let this axis be marked on the plate in red, and let the coördinates of star i ($i = 1 \quad . \quad . \quad . \quad n$) referred to this origin and to these axes be x_i, y_i.

$$\text{Let } x = \frac{\Sigma x_i}{n}; \qquad y = \frac{\Sigma y_i}{n}.$$

These quantities $\overline{x}$, $\overline{y}$ may be set off on the machine, thus determining a point on the machine which we shall call G'. The point immediately beneath it and on the plate we shall call G. We may now transfer the origin to G, or to G' $(\overline{x}, \overline{y})$. Let the coördinates of star i referred to G, and to axes parallel to the original ones, be X_i, Y_i.

Then

$$x_i = \overline{x} + X_i.$$

$$\therefore \ \Sigma x_i = n\overline{x} + \Sigma X_i,$$

$$\therefore \ \Sigma X_i = 0.$$

$$\text{Similarly } \Sigma Y_i = 0.$$

Suppose we take the plate out and later replace it, but that G is no longer beneath G', because the plate has been shifted in some direction and turned through an angle θ. Let the coördinates of G, referred to G' as origin and the measuring and side scales as axes, be $x_0 y_0$, and the coördinate of star i referred to the same axes and origin be x'_i, y'_i; then $x'_i = x_0 + X_i \cos\theta - Y_i, \sin\theta.$

[5] Schlesinger: *Astrophysical Journal*, vol. 33, pp. 161 *et seq.*

Where x'_i, y'_i, x_o, y_o are measured parallel to the scales and have G' as origin and X_i, Y_i are measured parallel to the red axes and from G as origin. Suppose, further, that the relative temperature of the machine scale and plate have changed and that the change in any length is proportional to that length. Let the coördinates of star i, still referred to G and the axes parallel to the scale (after plate has been turned), be X'_i, Y'_i; then,

$$X'_i = KX_i \cos\theta - KY_i \sin\theta + Kx_o$$

Let $K\cos\theta = 1 - a$, $K\sin\theta = b$, $Kx_o = -c$.

Then

$$X'_i - X_i + aX_i + bY_i + c = 0 \quad \text{(a)}$$

provided the measures were exact. Since they are not, we write

$$X'_i - X_i + aX_i + bY_i + c = v_i \quad (1)$$

There will be as many equations as there are comparison stars. Equation (1) is the same with the same notation as that given by Schlesinger and numbered (1); that is, X'_i is measured on the turned, displaced, and stretched plate from G' and parallel to the scales on the machine.

Hence, since $\Sigma X_i = o$ and $\Sigma Y_i = o$,

$$\left.\begin{aligned} [X^2]a + [X\cdot Y]b &= -[X(X'-X)] \\ [X\cdot Y]a + [Y^2]b &= -[Y(X'-X] \\ n\cdot c &= -[X'-X] = -[X']\cdot \end{aligned}\right\} \quad (2)$$

Hence

$$\left.\begin{aligned} a &= \frac{[Y(X'-X)]\,[X\cdot Y] - [X(X'-X)]\,[Y^2],}{[X^2]\,[Y^2] - [X\cdot Y]^2} \\ &= 1 - \frac{[X\cdot X']\,[Y^2] - [X'\cdot Y]\,[X\cdot Y]}{[X^2]\,[Y^2] - [X\cdot Y]^2} \\ b &= \frac{[X\,(X'-X)]\,[X\cdot Y] - [Y(X'-X)]\,[X^2]}{[X^2]\,[Y^2] - [X\cdot Y]^2}, \\ &= \frac{[X\cdot X']\,[X\cdot Y] - [X'\cdot Y]\,[X^2]}{[X^2]\,[Y^2] - [X\cdot Y]^2} \\ c &= -\frac{1}{n}[X']. \end{aligned}\right\} \quad (3)$$

From (a) it follows that

$$X_i = aX_i + bY_i + c + X'_i \quad (4)$$

That is, the x-coördinate of any object referred to G on the standard plate and to the axes chosen for the standard plate equals the x-coördinate measured on the comparison plate from the fixed point on the scale parallel to the turned axes $+aX$

(measured on the standard plate from G and parallel to the axes of the standard plate) + bY, measured in the same way, + c.

Suppose, instead of setting up the standard plate a second time that we set up another plate, and suppose, further, that the comparison stars and G are affected in the same way as the parallax star is by precession, aberration, and refraction, and that they have neither proper motion nor parallax. Let the comparison plate be called plate I, and let the two plates be superposed so that each of the comparison stars and G are exactly superposed. Suppose we mark on the standard plate the position of the parallax star on plate I. Call this point referred to G and the red axes

$$\xi,\ \eta,\ \text{then}$$

$$X'_\pi = X_\pi + a\xi + b\eta + c \ldots\ldots\ldots\ldots\ldots\ldots\ldots (4^1)$$

If we substitute in (4),

$$\xi = X_\pi \text{ and } \eta = Y_\pi\,,$$

and the value of a, b, and c, derived from (3), we get

$$\left.\begin{aligned} m' &= X'_\pi + X_\pi \\ &- X'_1\left\{\frac{X_1(X_\pi[Y^2]) - Y_1(X_\pi[XY]) + Y_1(Y_\pi[X^2]) - X_1(Y_\pi[X\cdot Y])}{[X^2][Y^2] - [XY]^2} + \frac{1}{n}\right\} \\ &- X'_2\left\{\frac{[X_2(X_\pi[Y^2] - Y_2[X_\pi[XY]) + Y_2(Y_\pi[X^2]) - X_2(Y_\pi[X\cdot Y]}{[X^2][Y^2] - [XY]^2} + \frac{1}{n}\right\} \end{aligned}\right\} . (5)$$

Or, letting D_1, D_2 . . . be the coefficients of $-X'_1$, $-X'_2$, equation (5) becomes

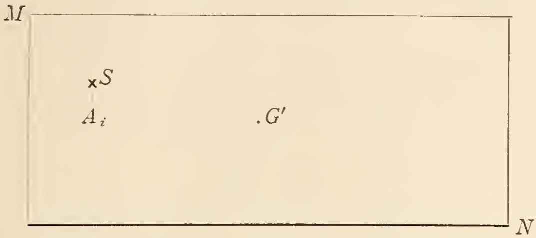
$$m' = \xi - X_\pi = X'_\pi - \Sigma X'_i Di$$

In this investigation, these equations, barring the substitutions of X_π, Y_π for ξ and η, respectively, and the fact that a, b, and c have been determined by least square solutions, are true equations, not approximations. No terms of any order are neglected.

The error introduced by the substitution of ξ, η, for X_π, Y_π, is smaller than the error of measurement. For example, suppose the parallax of the star is 0″.5, and that the standard plate and plate I were taken at the extreme positions in the parallactic ellipse—most unfavorable cases—then for an error of orientation of 8′, of 15′, and of 30′ the error introduced by the above substitution is respectively 0.0005, 0.0009, and 0.0019 revolution of the micrometer screw.

The quantities X_i may as well be measured from any point on the machine (*e.g.*, the zero point) as from G', and this we did.

FIG. 5.



Let MN be the plate, G' the centre of gravity of the comparison stars, S any star whose position projected on x-axis is A_i, and let any place on the scale be o.

Then

$$
\begin{aligned}
m' &= \overline{A_\pi G'} - \Sigma D \overline{A_i G^1}. \\
&= \overline{OA_\pi} - \overline{OG'} - \Sigma D (\overline{OA_i} - \overline{OG'}) \\
&= \overline{OA_\pi} - \overline{OG'} - \Sigma D\overline{OA_i} + \overline{OG'}\,\Sigma D \\
&= \overline{OA_\pi} - \Sigma D\overline{OA_i} \\
&= X_\pi - \Sigma DX_i
\end{aligned}
$$

where now X_π and X_i are measured from any point on the scale and D_i are the quantities defined on page 24. It then becomes necessary only to measure the coördinates of the stars, reading their positions directly from the scale and by means of equation (5) computing the m' for each plate.

The advantages of this method of reduction are very fully and clearly discussed in Schlesinger's paper. The only change that we made was to compute the D's to four instead of three decimal places and round them off to three instead of two decimal places.

We have introduced a correction made necessary by the approximate values of D_i.

According to the form in which we compute D and m, where D is the *absolutely correct* value, we should have for our standard plate

$$m = X\pi - \Sigma D_i X_i = o.$$

However, we do not use the absolute value of D, but compute it to four decimal places and get an approximate value. Let us

call this value D_a and the approximation D_e. Then any value of D_i may be written

$$D_i = D_a + D_e.$$
$$\Sigma D_a = 1 \quad \text{(chosen in this manner).}$$
$$\Sigma D_i = 1 \quad \text{(must be, from form of computation).}$$

In practice we use

$$m = X_\pi - \Sigma D_a X_i$$

and neglect

$$- \Sigma D_e X_i.$$

Suppose we could shift the standard plate to the right or left without changing the orientation. We would then have

$$\begin{aligned} m &= (X_\pi + C) - \Sigma D_a(X_i + C) - \Sigma D_e(X^i + C) \\ &= X_\pi + C - \Sigma D_a X_i - C\Sigma D_a - \Sigma D_e X_i - C\Sigma D_e \\ &= X_\pi - \Sigma D_a X_i - \Sigma D_e X_i - C\Sigma D_e. \end{aligned}$$

If we again use $X_\pi - D_a X_i$, and neglect $- \Sigma D_e X_i$ as in the first instance, we still have to account for the term $- c\Sigma D_e$, or, in other words, the m in the first case would differ from the m in the second case by this amount.

It sometimes happens that C is twenty or more quarter millimetres and ΣD_e is not infrequently 0.0001 or 0.0002, in which case the error might amount to 0.002 or 0.004 quarter millimetres.

This could be corrected easily by subtracting the X_π used in computing the D's from the mean of the X_π on any other plate. This gives the quantity C. Then $C\ \Sigma D_e$ can be found.

When $\Sigma D_e = 0.0000$, there is no correction.

Having made this correction, we determine the parallax from the well-known equation

$$m = P\pi + T\mu + c.$$

The following table contains a summary of the results for fifty stars. The meaning of the columns is sufficiently clear to need no further explanation.

SUMMARY OF RESULTS.

No.	B. D. Number.	Star	R. A., 1900 hr.	R. A., 1900 min.	Declination, 1900	Magnitude	Spectrum	Proper motion	Parallax		No. of plates	Coördinates
1	+57° 2865	Σ3062	0	1.0	+57° 53′	6.1	F.	$0^{s}.0329$; 0″.038	+0″.030	±0″.008	12	Long.
2	28 103	ε Andromedæ		33.3	28 46	4.52	G_5	− .0173; − .248	.096	.015	12	Long.
3	57 150	η Cassiopeiæ		43.0	57 17	3.64	F_8	+ .1390; .522	.182	.009	14	Long.
4	46 536	Σ228	2	7.6	47 1	6.03	F	0.″112 in 225.°3	.069	0.009	12	Long.
5	37 655	20 Persei		47.4	37 56	5.6	F	$0^{s}.0047$; −0″.082	.025	.011	12	Long.
6	22 737	OΣ (App.) 54	4	36.2	+22 46	7.8	..	− .0016; − .042	− .053	.009	12	Long.
7	22 739	τ Tauri		36.2	22 46	4.33	A	+ .0004; .022	+ .012	.013	12	Long.
8	10 654	Lalande 9091		45.7	10 54	7.9	..	....	.003	.014	10	Long.
9	9 898	ϕ^2 Orionis	5	31.4	9 15	4.4	K	.0062; .307	.027	.006	12	Long.
10	27 1164	OΣ 149	6	30.2	27 22	6.9	..	....	.048	.013	11	Long.
11	− 0 1462	Lalande 13198		45.7	− 0 25	5.8	A	.0005; .175	.015	.008	14	Long.
12		Nova Geminorum No. 2, 1912		49.3	+32 15	var.	Nova		− .019	.013	14	Long.
13	+20 1687	ζ Geminorum		58.1	20 42	var.	G	− .003; .008	+ .017	.007	12	Long.
14	21 1528	Lalande 13849	7	4.2	21 25	6.5	F_8	.0120; .482	.019	.010	12	Long.
15	5 1739	Procyon		34.1	5 29	0.5	F_5	.0466; 1.030	.287	.012	11	Long.
16	2 1854	13 Canis Minoris		57.1	2 36	4.5	K	.0026; +0 .099	.035	.008	14	Long.
17	12 1759	β 581		58.8	12 35	8.7		+ .0053; − .118	.082	.009	12	Long.
18	18 1867	ζ Cancri (large component)	8	6.5	17 57	6.0	F	.0046; .110	.030	.007	13	Long.
		ζ Cancri (small component)							.035	.011	13	
19	−12 2449	Lalande 16304		13.7	−12 18	6.0	F	.0191; .991	.075	.007	12	Long.
20	+42 1956	10 Ursæ Majoris		54.2	+42 11	4.1	F	− .0388; .261	.086	.015	12	Long.
21	29 1883	Lalande 18286	9	12.0	29 0	7.6		+ .0053; .512	.078	.015	12	Long.
22	41 2076	Bradley 1433	10	16.3	41 44	5.9	G	− .0109; .150	.080	.007	20	Long.
23	56 1459	36 Ursæ Majoris		24.2	56 30	4.8	F	.0215; .038	.103	.012	12	Long.
24	36 2147	Lalande 21185		57.9	36 38	7.8		.0469; 4.746	.443	.010	14	Long.
25	61 1246	OΣ235	11	26.7	61 38	5.5	F	.0005; 0.079	.051	.013	12	R. A.

SUMMARY OF RESULTS—(*Continued*).

No.	B. D. Number	Star	R. A., 1900	Declination, 1900	Magnitude	Spectrum	Proper motion	Parallax	No. of plates	Coördinates
			hr. *min.*							
26	+15° 2383	β Leonis	44.0	15 8	2.2	A_2	$-0^s.0342$; $-0''.123$	$+0''.116 \pm 0''.013$	16	Long.
27	11 2589	Lalande 25224	13 34.7	11 15	5.5	A	.0076; .011	− .016 .012	12	Long.
28	9 2882	Σ 1835. Bright component	14 18.5	8 54	5.1	A	.0046; − .025	+ .011 .005	12	Long.
		β 1111			6.6			.013 .007	12	Long.
29	42 2531	OΣ 285	14 41.7	42 49	7.1			− .028 .015	12	R. A.
30	37 2636	μ Bootis	15 20.7	37 44	4.5	F	.0126; + .078	+ .033 .013	14	Long.
31	37 2637	μ^2 Bootis	20.7	37 44	6.7	K	.0122; .093	.054 .011	14	Long.
32	26 2722	γ Coronæ Borealis	38.6	26 37	3.9	A	.0075; .030	.031 .006	12	Long.
33	31 2884	ζ Herculis	16 37.5	31 47	3.0	G	.0364; .385	+ .086 .008	15	Long.
34	28 2624	Σ 2107	48.0	28 50	8.0			.006 .006	14	Long.
u 35	33 2864	μ Herculis	17 13.6	33 12	var.	B_3	.0016; − .013	− .031 .007	12	Long.
36	61 1678	26 Draconis	34.0	61 58	5.3	F	+ .0350; .500	+ .080 .016	20	Long.
37	2 3482	70 Ophiuchi	18 0.4	2 31	4.1	K	.0169; 1.102	.181 .009	12	Long.
38	32 3267	Bradley 2388	53.3	32 47	5.2	G	.0137; 0.160	.126 .017	12	Long.
39	44 3234	δ Cygni	19 41.9	44 53	3.0	A	.0050; + .037	.049 .008	10	Long.
40	44 3242		42.8	44 52	9.2			− .012 .007	12	Long.
41	14 4369	β Delphini	20 32.9	14 15	3.7	F_5	.0074; − .037	+ .016 .011	12	Long.
42	35 4234	X Cygni	39.5	35 14	var.	F_{5p}		.000 .008	15	Long.
43	38 4343	61^1 Cygni	21 2.4	38 15	5.6	K_5	.3523; + 3.242	.301 .009	16	Long.
		61^2 Cygni						.299 .021	15	Long.
44	37 4240	τ Cygni	10.8	37 37	3.8	F	.0133; 0.427	.023 .016	14	Long.
45	24 4463	κ Pegasi	40.1	25 11	5.0	F_5	.0024; .002	.073 .009	12	Long.
46	24 4533	ι Pegasi	22 2.4	24 51	4.0	F_5	.0220; .018	.063 .011	12	Long.
47	56 2741	ε Cephei	11.3	56 33	4.2	A_5	.0544; .044	.030 .008	12	Long.
48	74 1006	π Cephei	23 4.7	74 51	4.6	G_5		− .020 .012	12	R. A.
49	56 2966	Bradley 3077	8.5	56 37	5.7	K	.2522; .296	+ .181 .009	15	Long.
50	26 4734	85 Pegasi	56.8	26 34	5.9	G	.0622; − .986	.101 .008	16	Long.

We are emphasizing at this observatory the determination of the parallax of binary stars whose orbits are well determined. From the preceding table have been selected all such binaries whose parallaxes are positive. Choosing for each binary those elements of its orbit that seem best, we computed the linear dimensions of the orbit, the mass and the luminosity of the system in terms of the mass and luminosity of the sun. The table which follows exhibits the results. We have also found the ratio of the mass to the luminosity and written it in the column headed $\frac{M}{L}$. The last column contains the name of the computer of the elements of the orbit that we have used.

The most significant facts shown by the table are that in general the sizes of the orbits are of the same order of magnitude as those of the outer planets; that the masses and luminosity of the systems are comparable with those of the sun. Practically all the spectra belong to the types *F* and *G*. We had rather expected that the ratio $\frac{M}{L}$ would run more nearly uniform than it does.

No.	Star	α (1900) hr. min.	δ (1900)	Magnitude	Spectrum	Parallax		Period	S. Major Axis In Arc	S. Major Axis A. U.	Mass ⊙ = 1	Luminosity ⊙ = 1	L/M	Orbit by
1	Σ 3062	0 1	+57° 53′	6.10	F	+0″.030	±0″.008	105ʸ.55	1″.44	41.14	6.25	5.53	0.88	Doberck.
3	η Cassiopeiæ = Σ60	43	57 17	3.64	F_8	.182	.009	327.87	9 .48	50.70	1.21	1.87	1.55	Doberck.
5	20 Persei = β524	2 47	37 56	5.6	F	.025	.011	33.33	0 .16	5.33	0.14	11.93	85.21	Aitken.
8	β883 = Lalande 9091	4 45	10 54	7.9		.003	.013	16.61	0 .19	23.75	48.56	20.17	0.42	Aitken.
18	ζ Cancri (A—component)			5.6		.030	.007					8.76		
	ζ Cancri (BC—component)	8 6	17 57	6.3	F	.035	.011	60.083	0 .856	24.46	4.05	3.52	0.87	Doberck.
21	Lalande 18286	9 12	29 0	7.6		.078	.015	34.00	0 .6692	8.06	0.45	0.25	0.56	See
26	OΣ 235	11 26	61 38	5.47	F	.051	.013	71.9	0 .78	13.93	0.52	3.86	7.42	Aitken.
28	Σ1835 {Bright component	14 18	8 54	5.11	A	.011	.005							
	Σ1835 {β 1111			6.64		.013	.007	44.32	0 .26	14.44	1.53	8.38	5.41	Aitken.
31	μ^2 Bootis	15 20	37 44	6.66	K	.054	.011	219.42	1 .2679	21.49	0.21	1.16	5.52	Doberck.
32	γ Coronæ Borealis	38	26 37	3.93	A	.031	.006	73.0	0 .736	20.44	1.60	3.86	24.13	See.
33	ζ Herculis	16 37	31 47	3.00	G	.086	.007	34.53	1 .355	14.89	2.77	14.2	5.13	Doberck.
37	70 Ophiuchi	18 0	2 31	4.07	K	.181	.009	86.66	4 .5227	24.32	1.91	1.27	0.66	Doberck.
38	Bradley 2388	53	32 47	5.21	G	.122	.019	45.85	1 .04	8.19	0.26	0.95	3.65	Aitken.
41	β Delphini	20 32	14 15	3.72	F_5	.016	.011	26.79	0 .480	22.86	16.65	138.0	8.29	Aitken.
44	τ Cygni	21 10	37 37	3.83	F	.023	.014	47.0	0 .91	32.50	15.54	70.6	4.54	Aitken.
45	κ Pegasi	40	25 11	5.0	F_5	.073	.009	11.37	0 .29	3.72	0.40	3.06	7.65	Burnham.
50	85 Pegasi	23 56	26 34	5.85	G	.101	.008	26.3	0 .82	7.74	0.67	0.76	1.13	Bower & Furner

PART IV.

Observational Data, Solutions, and Result.

In the detailed results that follow there is given for each star its *BD* number, together with some other ordinarily used designations; its position given to minutes for the epoch of 1900; its magnitude, taken, if possible, from Harvard Photometry; its proper motion, taken, if possible, from Boss's Fundamental Catalogue; its spectrum, taken from the Annals of Harvard College Observatory, vol. 50.

The observational data for each star are given in Table 1. Columns 1, 2, 3, 5, and 7 need no explanation. The initials in column 4 have the following signification: B. denotes Barton; Ma., Matos; M., Miller; P., Pitman; S., Miss Steele. It is our custom to examine under the microscope all plates soon after they are developed. At that time the quality of the images is estimated. There are five grades that we measure—1, 2, 3, 4, and 5: the higher the grading, the better the plate. The quality of the image in column 6 is usually that assigned at this examination. It is occasionally changed by the person who measures the plate.

For Table 2, which contains the data that enter into the reduction, only columns 2 and 3 need comment. In column 2 is given the weight of the plate assigned by the person who measures it, the quality of the images and the number of exposures being the chief elements entering into the weight. T is the time of the observation given in days from the mean epoch of the series.

A table, not numbered, contains the data of the comparison stars. The coördinates X and Y are referred to the parallax star as origin, and are measured in the coördinates in which the parallax star is. They are given in quarter millimetres. The normal equations follow, together with their solution. The proper motion, μ, is given in seconds of arc per hundred days.

B.D. $+ 57° 2865$. $\Sigma 3062$. ($0^h 1^m.0$, $+ 57° 53'$.)
Mag. 6.1. $\mu = + 0^s.0329$; $+ 0''.038$. Spectrum F.

The measures were made in longitude. The star is a close binary with a period of 105.55 years. After some experimentation the exposures were made long enough so that the images of the components could not be separated. The resulting image of the parallax star was long. We bisected this long image.

Russell finds for this star a hypothetical parallax of $0''.046$.

TABLE 1.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Dec. 9, 1912	+0 15	M.	3	3	1
2	Dec. 12, 1912	0 00	M.	2	1	1
3	Nov. 20, 1914	−0 30	P.	3	4	0
4	July 22, 1915	−0 33	P.	3	4	0
5	July 24, 1915	0 10	M.	3	4	0
6	Aug. 14, 1915	0 26	P.	3	4	0
7	Aug. 15, 1915	0 53	P.	3	4	0
8	Aug. 17, 1915	0 55	P.	2	3	0
9	Aug. 18, 1915	1 0	P.	3	3	0
10	Dec. 22, 1915	−0 6	P.	3	3	1
11	Dec. 26, 1915	+0 20	M.	3	3	1
12	Dec. 31, 1915	0 17	P.	2	3	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.8	−8.24	−0.694	−0.141	.007	M.
2	.6	8.21	.732	.122	.012	M.
3	.9	−1.13	−0.420	−0.044	.003	M.
4	.9	+1.31	+1.014	+0.005	.005	M.
5	.9	1.33	1.015	−0.001	.001	M.
6	.9	1.54	0.958	+0.006	.003	M.
7	.9	1.55	.952	−0.002	.005	M.
8	.7	1.57	.939	+0.002	.001	M.
9	.9	1.58	.933	0.006	.003	M.
10	.8	+2.84	−0.829	+0.021	.012	M.
11	.8	2.88	.864	.003	.006	M.
12	.7	2.93	.902	.005	.004	M.

COMPARISON STARS.

No.	*X*	*Y*	Dependence	Diameter	B. D. No.	Magnitude
2	−129.542	+138.754	+0.111	0.50	+57° 2858	8.8
3	+198.941	−165.757	0.383	0.36	2867	9.2
5	2.075	240.594	−0.035	0.38		
9	9.183	+100.661	+0.316	0.44	2866	9.1
10	− 80.656	166.938	0.225	0.42		
π	+ 46.503	29.588		0.52		

Normal equations:

$$9.800c + 1.770\mu + 1.686\pi = -0.190.$$
$$+126.413 \quad +10.309 \quad = +1.661.$$
$$+7.477 \quad = +0.142.$$

Solution:
$$\mu = +0''.061 \pm 0''.002.$$
$$c = -0\ .023.$$
$$\pi = +0''.030 \pm 0''.008.$$

p. e. unit weight $\pm 0''.020$.

B.D. + 28° 103. ϵ Andromedæ. ($0^h 33^m.3$, + 28° 46′.)
Mag. 4.52. $\mu = -0^s.0174; -0''.248$. Spectrum G_5.

The measures were made in longitude.

Slocum found a parallax of this star of 0″.042 ± 0″.014.

TABLE 1.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Dec. 12, 1913	+0 30	P.	3	3	0
2	Dec. 13, 1913	1 0	M.	3	2	1
3	Dec. 30, 1913	0 5	P.	3	3	0
4	Jan. 6, 1914	0 38	P.	3	4	0
5	July 29, 1914	−0 5	S.	2	4	0
6	Aug. 23, 1914	+0 0	P.	3	5	0
7	Sept. 4, 1914	0 50	P.	3	3	2
8	Dec. 12, 1914	−0 16	M.	3	3	1
9	Jan. 1, 1915	+0 24	P.	3	2	2
10	July 22, 1915	−0 26	P.	2	4	0
11	Aug. 14, 1915	+0 0	P.	3	5	0
12	Aug. 15, 1915	−0 6	P.	3	5	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.7	−2.79	−0.858	−0.179	.015	S.
2	.8	2.78	.867	.161	.003	S.
3	.8	2.61	.965	.162	.008	S.
4	.8	2.54	.981	.157	.014	S.
5	1.0	0.50	+0.972	.187	.012	S.
6	1.0	0.25	.765	.177	.008	S.
7	.8	0.13	.614	.191	.001	S.
8	.8	+0.86	−0.857	.253	.010	S.
9	.8	1.06	.970	.253	.004	S.
10	.9	3.08	+1.001	.260	.009	S.
11	1.0	3.31	.860	.256	.003	S.
12	.9	3.32	.851	.249	.012	S.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
2	+132.441	+ 13.767	+0.146	0.28	+28° 105	9.4
3	−244.844	− 59.207	.569	0.72	100	9.4
6	66.033	+ 87.211	−0.051	0.65	104	9.3
8	+178.436	− 41.770	+0.336	0.19	106	9.0
π	− 56.879	50.153		0.96		

Normal equations:

$$10.300c + 1.455\mu + 0.441\pi = -2.145.$$
$$+53.473 \quad +13.626 \quad = -1.175.$$
$$+ 8.098 \quad = -0.219.$$

Solution:

$$\mu = -0''.101 \pm 0''.006.$$
$$c = -0\ .206.$$
$$\pi = +0''.096 \pm 0''.015.$$

p. e. unit weight $\pm 0''.031$.

B. D. + 57° 150. η Cass. = Σ60. ($0^h 43^m.0$, + 57° 17′.)
Mag. 3.64. μ + $0^s.1390$; −0″.522. Spectrum F_8.

The measures are in longitude. This is a binary star with a period of 327.87 years.

Other parallaxes published are as follows: By Russell, 0″.189 (photographic). By Peters (heliometer), 0″.18. By Davis (photographic), 0″.443. By Russell (hypothetical), 0″.160.

TABLE 1.

No.	Date	Hour angle		Observer	No. of exposures	Quality of images	No. of interpolations
		hr.	*min.*				
1	Nov. 28, 1912	+0	0	M.	3	3	0
2	Nov. 29, 1912	0	0	B.	3	3	0
3	Nov. 30, 1912	−1	12	S.	3	4	1
4	Dec. 13, 1912	+0	0	B.	3	4	0
5	Dec. 15, 1912	0	0	S.	3	4	0
6	Aug. 15, 1915	−0	13	P.	3	4	0
7	Aug. 17, 1915	1	6	P.	3	4	0
8	Aug. 18, 1915	1	12	P.	3	2	2
9	Aug. 22, 1915	0	14	P.	3	5	0
10	Aug. 23, 1915	1	0	P.	3	4	0
11	Aug. 25, 1915	1	0	P.	3	4	0
12	Dec. 12, 1915	−0	13	S.	3	5	0
13	Dec. 15, 1915	0	13	P.	3	3	0
14	Dec. 22, 1915	0	16	P.	3	4	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	1.0	−6.67	−0.452	−0.561	.001	S.
2	1.0	6.66	.470	.564	.005	S.
3	.8	6.55	.482	.575	.015	S.
4	1.0	6.52	.668	.559	.001	S.
5	1.0	6.50	.692	.555	.005	S.
6	.9	+3.23	+0.984	.018	.004	S.
7	.8	3.25	.975	.026	.013	S.
8	.8	3.26	.971	.017	.004	S.
9	.8	3.30	.948	.004	.008	S.
10	.9	3.31	.943	.013	.002	S.
11	.9	3.33	.930	.010	.001	S.
12	.9	+4.42	−0.645	.015	.003	S.
13	.9	4.45	.684	.025	.006	S.
14	.9	4.52	.765	.023	.005	S.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
3	-167.512	$+151.214$	$+0.199$	0.60	56° 128	8.5
4	$+\ 42.181$	27.484	0.261	0.39	57° 155	9.4
6	166.439	6.749	0.295	0.37		
13	$-\ 41.110$	-185.448	0.245	0.77	57° 145	8.9
π	$+\ 16.689$	6.063		0.42		

Normal equations:

$$12.600c - \ 2.888\mu + \ 0.333\pi = - \ 2.832.$$
$$+317.669 \ +25.170 \ = +17.305.$$
$$+ \ 7.544 \ = + \ 1.466.$$

Solution:

$$\mu = +0''.232 \pm 0''.001.$$
$$c = -0\ .212.$$
$$\pi = +0''.182 \pm 0''.009.$$

p. e. unit weight $\pm 0''.022$.

B. D. $+46°$ 536. Σ 228. ($2^h\ 7^m.6, +47°\ 1'$.)
Mag. 6.03. $\mu = 0''.112$ in $225°.3$. Spectrum F.

The measures were in longitude. This star is a binary, the orbit of which is very uncertain.

Russell finds a hypothetical parallax for it of $0''.026$.

TABLE I.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Dec. 11, 1913	—0 07	M.	3	2	1
2	Dec. 19, 1913	0 20	S.	3	4	0
3	Dec. 29, 1913	+0 10	P.	3	4	1
4	Jan. 1, 1915	+0 18	P.	3	2	0
5	Jan. 15, 1915	−0 12	P.	2	1	0
6	Aug. 14, 1915	−0 5	P.	2	5	0
7	Aug. 15, 1915	0 32	P.	2	3	0
8	Aug. 17, 1915	0 23	P.	3	2	0
9	Aug. 18, 1915	0 21	P.	3	3	0
10	Aug. 22, 1915	0 15	P.	3	5	0
11	Aug. 25, 1915	0 18	P.	3	3	0
12	Jan. 7, 1916	+0 0	S.	1	3	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.8	−4.39	−0.523	−0.013	.002	S.
2	.7	4.31	.635	.025	.009	S.
3	.9	4.21	.757	.011	.008	S.
4	.7	−0.53	−.787	.063	.011	S.
5	.7	.39	.909	.054	.001	S.
6	.9	+1.72	+1.010	.044	.001	S.
7	.8	1.73	1.008	.055	.005	S.
8	.8	1.75	1.004	.045	.000	S.
9	.9	1.76	1.002	.046	.001	S.
10	1.0	1.80	0.989	.049	.003	S.
11	.8	1.83	.978	.040	.007	S.
12	.6	+3.18	−.844	.081	.004	S.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
2	+143.599	− 59.678	+0.375	0.37		
4	181.555	+143.520	0.154	0.58	+46° 541	9.3
7	−156.249	111.517	0.061	0.32	46° 535	9.5
11	168.906	−195.358	0.410	0.29		
π	+ 2.977	73.572		0.42		

Normal equations:

$$\begin{aligned} 9.600c + 0.126\mu + 1.954\pi &= -0.406. \\ +66.957 \quad +14.714 \quad &= -0.374. \\ +\ 7.640 \quad &= -0.104. \end{aligned}$$

Solution:

$$\begin{aligned} \mu &= -0''.041 \pm 0''.003. \\ c &= -0\ .045. \\ + &= +0''.069 \pm 0''.009. \end{aligned}$$

p. e. unit weight $\pm 0''.018$.

B. D. + 37° 655. 20 Persei = β524. ($2^h 47^m.4$, + 37° 56′.)
Mag. 5.6 − 6.7. $\mu = + 0^s.0047; - 0''.082$. Spectrum F.

The measures were in longitude. This star is a binary with a period of 33 years.

Slocum and Mitchell found (photographically) for this star a parallax of $-0''.012$. Russell finds a hypothetical parallax of $+0''.010$.

TABLE 1.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Dec. 29, 1913	+0 7	P.	3	5	0
2	Jan. 1, 1914	−0 26	P.	3	5	1
3	Jan. 5, 1914	0 10	P.	3	5	0
4	Sept. 21, 1914	0 14	P.	3	5	1
5	Sept. 22, 1914	0 7	P.	3	4	0
6	Sept. 28, 1914	0 20	P.	2	3	0
7	Sept. 30, 1914	+0 27	M.	3	4	1
8	Oct. 1, 1914	0 0	P.	3	5	1
9	Oct. 2, 1914	−0 17	P.	3	5	0
10	Dec. 18, 1914	+0 10	P.	2	2	0
11	Jan. 4, 1915	−0 10	P.	3	5	0
12	Jan. 10, 1915	+0 0	P.	3	4	1

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.7	−2.29	−0.713	+0.054	.009	S.
2	.8	2.26	.748	.072	.009	S.
3	.8	2.22	.791	.063	.000	M.
4	.8	+0.37	+0.800	.086	.010	M.
5	.9	0.38	.789	.070	.006	H.
6	.6	0.44	.720	.075	.001	M.
7	.7	0.46	.695	.075	.001	M.
8	.7	0.47	.683	.063	.013	M.
9	.7	0.48	.670	.085	.009	M.
10	.8	+1.25	−0.565	.076	.006	M.
11	.6	1.42	.778	.069	.000	M.
12	.6	1.48	.838	.065	.005	M.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
1	−240.025	+134.497	+0.261	0.39	+37° 651	9.3
2	96.920	−172.402	0.195	0.44	37° 652	8.7
3	+ 99.313	+157.480	0.301	0.33	37 658	9.3
7	237.630	−119.576	0.243	0.37		
π	6.147	+ 19.837		0.37		

Normal equations:

$$8.700c - 0.558\mu + 0.064\pi = 0.621.$$
$$16.293 \quad +3.297 \quad = 0.006.$$
$$+4.706 \quad = 0.035.$$

Solution:

$$\mu = +0''.008 \pm 0''.006.$$
$$c = +0\ .071.$$
$$\pi = +0''.025 \pm 0''.011.$$

p. e. unit weight $\pm 0''.023$.

B. D. $+22^\circ$ 737. oΣ (App.) 54. ($4^h\,36^m.2$, $+22^\circ 46'$.)
Mag. 7.8. $\mu = -0^s.0016$; $-0''.042$.

The measures were in longitude. This star was on the same plate as τ Tauri (see next star). The parallax was reduced, using four comparison stars. Two of them, number 1 and number 6, were also used in reducing the parallax of τ Tauri. The same set of plates were used to determine the parallax of this star and τ Tauri, and the measures of all the comparison stars of both fields were made without removing the plate from the machine. No other parallax of this star has been published.

TABLE 1.

No.	Date	Hour angle	Observer	No. of expo-sures	Quality of images	No. of inter-polations
		hr. min.				
1	Jan. 1, 1915	+0 07	P.	2	2	0
2	Jan. 5, 1915	0 46	M.	3	3	1
3	Feb. 10, 1915	0 14	P.	3	5	0
4	Oct. 3, 1915	−0 45	P.	3	4	0
5	Oct. 12, 1915	0 15	P.	3	4	0
6	Oct. 23, 1915	+0 40	S.	3	2	0
7	Oct. 24, 1915	0 50	P.	3	3	0
8	Oct. 30, 1915	0 5	P.	2	3	0
9	Jan. 23, 1916	+0 20	S.	2	3	0
10	Feb. 19, 1916	1 15	Ma.	2	2	0
11	Mar. 4, 1916	1 30	Ma.	3	2	0
12	Mar. 9, 1916	2 0	S.	2	3	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.7	−2.63	−0.484	−0.046	.002	S.
2	.8	2.59	.545	.044	.003	S.
3	1.0	2.23	.928	.046	.001	S.
4	.9	+0.12	+0.873	.061	.005	S.
5	.8	0.21	.785	.040	.014	S.
6	.7	0.32	.652	.052	.000	S.
7	.8	0.33	.639	.054	.002	S.
8	.6	0.39	.555	.064	.013	S.
9	.8	+1.24	−0.773	.041	.007	S.
10	.7	1.51	.971	.030	.001	S.
11	.7	1.65	.991	.022	.008	S.
12	.8	1.70	.984	.031	.001	S.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
1	−150.657	+191.690	+0.404	0.81	+22° 735	8.7
3	168.634	−103.747	0.260	0.48	22° 732	9.5
4	+ 69.087	168.189	0.138	0.63		
6	250.202	+ 80.245	0.198	1.29	22 743	8.0
π	− 45.704	43.186				

Normal: $9.300c - 0.581\mu - 1.768\pi = -0.411.$
$+22.523 \; +0.484 \; = +0.084.$
$+5.851 \; = +0.017.$

Solution: $\mu = +0''.013 \pm 0''.004.$
$c = -0\,.046.$
$\pi = -0''.053 \pm 0''.009.$

p. e. unit weight $\pm 0''.021$.

B. D. + 22° 739. τ Tauri. ($4^h36^m.2$, + 22° 46′.)
Mag. 4.33. $\mu = +0^s.0004; -0''.022.$ Spectrum A.

The measures were in longitude. This star is a spectroscopic binary and is supposed to be a close binary.

TABLE 1.

No.	Date	Hour angle hr. min.	Observer	No. of exposures	Quality of images	No. of interpolations
1	Jan. 1, 1915	+0 7	P.	2	2	0
2	Jan. 5, 1915	0 46	M.	3	3	1
3	Feb. 10, 1915	0 14	P.	3	5	0
4	Oct. 3, 1915	−0 45	P.	3	4	0
5	Oct. 12, 1915	0 15	P.	3	4	0
6	Oct. 23, 1915	+0 40	S.	3	2	0
7	Oct. 24, 1915	0 50	P.	3	3	0
8	Oct. 30, 1915	0 5	P.	2	3	0
9	Jan. 23, 1916	+0 20	S.	2	3	0
10	Feb. 19, 1916	1 15	Ma.	2	2	0
11	Mar. 4, 1916	1 30	Ma.	3	2	0
12	Mar. 9, 1916	2 0	S.	2	3	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.7	−2.63	−0.484	−0.049	.005	S.
2	.8	2.59	.545	.030	.014	S.
3	1.0	2.23	.928	.054	.008	S.
4	.9	+0.12	+0.873	−.055	.010	S.
5	.9	0.21	.785	.039	.006	S.
6	.7	0.32	.652	.036	.009	S.
7	.8	0.33	.639	.053	.007	S.
8	.8	0.39	.555	.043	.004	S.
9	.8	+1.24	−0.773	−.060	.009	S.
10	.7	1.51	.971	.056	.005	S.
11	.8	1.65	.991	.034	.018	S.
12	.8	1.70	.984	.057	...005	S.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
1	-172.260	$+165.268$	$+0.293$	0.81	$+22°$ 735	8.7
2	233.693	-35.895	.344	0.66	22 730	9.3
5	$+177.352$	183.196	0.207	0.44	22 742	9.5
6	228.599	$+53.823$	.156	1.29	22 743	8.0
π	-58.543	6.681				

Normal equations:

$$9.700c - 0.317\mu - 1.677\pi = -0.458.$$
$$+22.831 \quad +0.381 = -0.019.$$
$$+6.072 = +0.093.$$

Solution:

$$\mu = -0''.007 \pm 0''.006.$$
$$c = -0 \;.047.$$
$$\pi = +0''.012 \pm 0''.013.$$

p. e. unit weight $\pm 0''.030$.

B. D. + 10° 654. Lalande 9091 = β883. ($4^h 45^m.7$, + 10°54′.)
Mag. 7.9 – 7.9.

The measures were in longitude. This is a binary star with a period of 16.61 years.

Other results published are by Flint (transits) and Russell (hypothetical). Their results are, respectively, – 0″.030 and + 0″.028.

Table I.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Feb. 2, 1913	+0 50	M.	2	4	0
2	Feb. 7, 1913	0 6	B.	3	5	0
3	Sept. 24, 1913	–0 10	M.	3	5	1
4	Oct. 13, 1913	0 20	M.	3	5	0
5	Dec. 19, 1913	–0 45	S.	3	5	2
6	Dec. 30, 1913	0 45	P.	3	5	1
7	Jan. 1, 1914	0 40	P.	3	5	1
8	Sept. 16, 1914	–0 16	P.	2	4	0
9	Sept. 22, 1914	0 2	P.	3	5	0
10	Sept. 27, 1914	+0 5	S.	3	5	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.6	−3.27	−0.871	−0.014	.008	M.
2	.8	3.22	.909	0.015	.007	M.
3	.7	−0.93	+0.941	0.012	.003	M.
4	.6	0.74	.777	0.015	.007	M.
5	.8	−0.07	−0.272	0.016	.010	M.
6	.9	+0.04	.450	0.005	.001	H.
7	.9	0.06	.481	0.010	.004	M.
8	.7	+2.64	+0.983	+0.016	.009	M.
9	.9	2.70	.995	0.013	.005	M.
10	.8	2.75	.923	0.007	.001	M.

COMPARISON STARS.

No.	*X*	*Y*	Dependence	Diameter	B. D. No.	Magnitude
2	+113.095	− 53.665	0.520	0.76	+10° 659	9.1
3	24.963	+ 19.862	0.028	0.37		
4	−138.059	33.803	0.452	0.50	+10 652	9.4
π	2.969	− 12.051		0.60		

Normal equations:

$$33.147\mu + 0.879c + 9.234\pi = +0.155.$$
$$+7.704 + 1.109 = -0.038.$$
$$+4.728 = +0.040.$$

Solution:

$$\mu = +0''.022 \pm 0''.005.$$
$$c = -0\ .006.$$
$$\pi = +0''.003 \pm 0''.014.$$

p. e. unit weight $\pm 0''.020$.

B. D. + 9° 898. ϕ^2 Orionis. ($5^h\ 31^m.4$, + 9° 15′.)
Mag. 4. 39. $\mu = +0^s.0062;\ -0''.307$. Spectrum K.

This star is measured in longitude. This star has large proper motion. Slocum and Mitchell found for this star a parallax of $0''.010$.

TABLE 1.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Oct. 13, 1913	+0 25	M.	3	5	2
2	Oct. 22, 1913	1 15	S.	3	4	0
3	Nov. 5, 1913	1 0	S.	2	4	0
4	Feb. 26, 1914	+0 40	M.	3	4	1
5	Mar. 4, 1914	0 10	P.	3	5	0
6	Mar. 20, 1914	1 40	P.	2	2	1
7	Sept. 25, 1914	−0 30	S.	3	5	1
8	Sept. 28, 1914	+0 17	P.	2	5	0
9	Mar. 30, 1914	0 20	M.	2	5	0
10	Feb. 8, 1915	+0 6	P.	3	5	0
11	Feb. 10, 1915	0 35	P.	3	5	2
12	Feb. 19, 1915	0 32	P.	2	4	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.9	−2.48	+0.885	−0.185	.005	P.
2	.9	2.39	.800	.195	.005	P.
3	.8	2.25	.632	.191	.001	P.
4	1.0	−1.12	−0.955	.202	.007	P.
5	1.0	1.06	.979	.189	.005	P.
6	.8	0.90	.990	.188	.005	P.
7	.9	+0.99	+0.989	.176	.004	P.
8	.9	1.02	.978	.168	.005	P.
9	.7	1.04	.969	.171	.001	P.
10	1.0	+2.35	−0.821	.181	.005	P.
11	.8	2.37	.840	.171	.005	P.
12	.7	2.46	.913	.175	.001	P.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
2	+184.594	+ 93.140	+0.297	0.70		
8	−238.599	181.937	0.301	0.42		
10	174.614	−149.867	0.183	0.63		
11	+228.620	125.209	0.219	0.65		
π	0.939	+ 27.742		0.68		

Normal equations:

$$10.400c - 0.578\mu - 0.387\pi = -1.906.$$
$$+34.581 \quad -4.626 \quad = +0.250.$$
$$+8.475 \quad = +0.097.$$

Solution:

$$\mu = +0''.023 \pm 0''.003.$$
$$c = -0\ .183.$$
$$\pi = +0''.027 \pm 0''.006.$$

p. e. unit weight $\pm 0''.015$.

B.D. + 27° 1164. OΣ 149. ($6^h 30^m.2$, + 27° 22′.)
Mag. 6.9 − 9.4.

The measures were in longitude. This star is probably a binary with slow angular motion. No orbit has been computed for it. No other parallax has been published for this star.

TABLE 1.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Oct. 28, 1913	+0 23	P.	3	5	0
2	Nov. 1, 1913	−0 10	S.	3	3	1
3	Mar. 3, 1914	+1 15	M.	3	5	1
4	Mar. 15, 1914	1 25	M.	2	5	1
5	Oct. 31, 1914	+1 0	M.	3	3	0
6	Nov. 2, 1914	0 25	M.	2	5	0
7	Nov. 13, 1914	1 0	M.	3	5	0
8	Feb. 19, 1915	+0 36	P.	2	5	0
9	Feb. 21, 1915	0 25	M.	2	4	1
10	Feb. 28, 1914	0 20	M.	3	2	3
11	Mar. 4, 1915	0 50	M.	2	5	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.9	−3.02	+0.873	+0.033	.005	P.
2	.7	2.98	.838	.028	.010	P.
3	.9	−1.76	−0.904	.026	.005	P.
4	.8	1.64	.972	.028	.008	P.
5	.9	+0.66	+0.849	.059	.018	P.
6	.8	0.68	.830	.044	.004	P.
7	1.0	0.79	.709	.029	.010	P.
7	.7	+1.77	−0.794	.023	.001	P.
9	.8	1.79	.815	.027	.003	P.
10	.9	1.86	.879	.027	.003	P.
11	.7	1.90	.909	.006	.018	P.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
2	+152.502	+ 81.341	+0.437	0.75	+27° 1172	9.1
5	−160.040	31.649	0.638	0.64		
9	169.792	−129.926	−0.155	0.46		
10	+177.331	+ 16.934	+0.080	0.57	+27° 1174	9.5
π	5.090	77.225		0.71		

Normal equations:

$$9.100c - 0.097\mu - 0.717\pi = +0.292.$$
$$+31.147 \quad -4.730 \quad = -0.026.$$
$$+6.619 \quad = +0.041.$$

Solution:

$$\mu = +0''.004 \pm 0''.005.$$
$$c = +0\ .031.$$
$$\pi = +0''.048 \pm 0''.013.$$

p. e. unit weight $\pm 0''.032$.

B. D. — 0° 1462. Lalande 13198. ($6^h\ 45^m.7$, − 0° 25′.)
Mag. 5.83. $\mu = +\ 0^s.0005;\ -\ 0''.175$. Spectrum A.

This star is measured in longitude. Flint (transits) found a parallax of $+0''.25$ for this star.

TABLE 1.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Oct. 16, 1912	+0 0	M.	2	2	3
2	Oct. 20, 1912	0 6	B.	2	1	2
3	Nov. 26, 1912	0 12	B.	2	1	0
4	Feb. 18, 1913	+0 0	M.	2	2	2
5	Feb. 23, 1913	0 15	M.	2	3	3
6	Mar. 2, 1913	0 55	M.	2	4	1
7	Nov. 2, 1913	+0 23	P.	3	4	4
8	Nov. 17, 1913	1 0	M.	2	5	1
9	Nov. 20, 1913	0 20	P.	3	5	0
10	Dec. 4, 1913	0 30	P.	3	3	0
11	Dec. 11, 1913	1 10	P.	2	5	0
12	Feb. 25, 1914	+0 8	P.	3	2	3
13	Mar. 4, 1914	0 23	P.	2	5	0
14	Mar. 12, 1914	1 3	M.	3	5	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.6	−2.58	+0.978	+2.735	.009	M.
2	.6	2.54	.961	.727	.001	M.
3	.7	2.17	.607	.727	.002	M.
4	.6	−1.33	−0.725	.717	.003	P.
5	.6	1.28	.782	.713	.007	P.
6	.8	1.21	.852	.725	.006	S.
7	.8	+1.24	+0.878	.721	.004	M.
8	.8	1.39	.725	.715	.009	M.
9	.9	1.42	.689	.727	.003	S.
10	.9	1.56	.494	.728	.005	M.
11	.7	1.63	.384	.723	.001	M.
12	.8	+2.39	−0.801	.714	.004	S.
13	.7	2.46	.868	.731	.013	M.
14	.7	2.54	.928	.721	.003	M.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
1	− 95.826	+ 34.862	+0.15	0.87	−0° 1455	8.8
2	87.309	123.598	0.14	0.61	−0° 1457	9.3
5	+ 34.863	−218.493	0.16	0.80	−0° 1464	9.0
7	−132.556	+190.926	0.14	0.57	−0° 1454	9.5
12	+217.746	−184.809	0.14	0.57	−0° 1467	9.0
13	351.762	+ 46.669	0.10	0.64	−0° 1471	9.3
14	−288.677	7.249	0.17	0.48		
π	20.263	− 6.838		0.76		

Normal equations:

$$36.361\mu + 4.209c - 2.891\pi = 11.440.$$
$$+10.206 \quad +0.720 \quad = 27.785.$$
$$+6.085 \quad = \quad 1.980.$$

Solution:

$$\mu = -0''.002 \pm 0''.003.$$
$$c = +2\ .722.$$
$$\pi = +0''.015 \pm 0''.008.$$

p. e. unit weight $\pm 0''.019$.

Nova Geminorum No. 2, 1912. ($6^{h}\ 49.^{m}3$, $+ 32^{\circ}\ 15'$.)
Mag. var. Spectrum Nova.

The measures were in longitude. Slocum and Mitchell found the parallax to be $+0''.006$.

TABLE I.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Mar. 18, 1912	+0 12	B.	3	2	0
2	Mar. 22, 1912	0 30	B.	3	1	0
3	Mar. 30, 1912	1 12	B.	3	2	0
4	Oct. 15, 1912	+0 42	B.	3	1	0
5	Oct. 16, 1912	0 0	M.	2	3	2
6	Oct. 17, 1912	−0 42	B.	3	5	0
7	Oct. 20, 1912	0 54	B.	3	2	1
8	Nov. 18, 1912	+0 0	M.	3	3	0
9	Nov. 19, 1912	—0 18	B.	3	3	2
10	Feb. 10, 1913	−0 18	B.	3	5	0
11	Feb. 13, 1913	+0 0	M.	3	3	1
12	Mar. 5, 1913	0 0	B.	3	5	1
13	Mar. 12, 1913	0 18	B.	3	3	0
14	Nov. 1, 1913	+1 0	M.	3	3	2

TABLE I

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.7	−2.89	−0.972	+0.313	.019	M.
2	.7	2.85	.986	.338	.006	S.
3	.7	2.77	1.000	.358	.026	M.
4	.9	−0.78	+0.974	.334	.012	S.
5	.8	0.77	.970	.321	.001	S.
6	.5	0.76	.966	.302	.020	S.
7	.5	0.73	.951	.327	.005	M.
8	.9	0.44	.717	.317	.005	S.
9	.9	0.43	.672	.314	.008	S.
10	.5	+0.40	−0.651	.325	.003	M.
11	.9	0.43	.690	.331	.003	S.
12	.7	0.63	.894	.322	.006	S.
13	.6	0.70	.942	.319	.009	M
14	.7	+3.04	+0.869	.331	.012	S.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude.
2	−134.532	+ 51.185	+0.87	0.38		
3	136.549	− 21.534	−0.28	0.43	+32° 1422	9.2
6	+271.081	29.651	+0.41	0.32		
π	32.650			0.40		

Normal equations:

$$26.120\mu - 5.229c + 4.000\pi = -1.744.$$
$$+10.009 \quad +0.256 \quad = +3.258.$$
$$+7.701 \quad = +0.048.$$

Solution:

$$\mu = -0''.005 \pm 0''.008.$$
$$c = +0\ .325.$$
$$\pi = -0''.019 \pm 0''.013.$$

p. e. unit weight $\pm 0''.035$

B. D. + 20° 1687. ζ Geminorum. (6^h $58^m.1$, + 20° 41′.8.)
Mag. var. μ —$0^s.0003$; —0″.008. Spectrum G.

The measures were in longitude. This star is a spectroscopic binary. No other parallax has been published.

TABLE 1.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Mar. 8, 1915	+0 7	P.	2	3	0
2	Mar. 14, 1915	0 45	M.	3	3	0
3	Mar. 16, 1915	0 50	M.	3	3	0
4	Oct. 11, 1915	+0 30	M.	2	4	0
5	Oct. 12, 1915	0 37	P.	2	2	0
6	Oct. 24, 1915	−0 48	P.	3	4	0
7	Nov. 9, 1915	0 15	P.	3	3	0
8	Nov. 24, 1915	+1 40	M.	3	3	0
9	Nov. 27, 1915	0 0	M.	2	3	0
10	Mar. 4, 1916	+0 20	Ma.	2	3	0
11	Mar. 9, 1916	0 30	S.	3	5	0
12	Mar. 11, 1916	0 40	Ma.	3	3	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.8	−2.12	−0.889	+0.108	.005	S.
2	.8	2.06	.931	.099	.004	S.
3	.8	2.04	.944	.103	.000	S.
4	.8	+0.05	+0.995	+.106	.003	S.
5	.7	0.06	.993	.113	.004	S.
6	.9	0.18	.950	.103	.005	S.
7	.8	0.34	.829	.110	.002	S.
8	.9	0.49	.657	.115	.008	S.
9	.8	0.52	.615	.103	.004	S.
10	.8	+1.50	−0.862	+.097	.004	S.
11	1.0	1.55	.903	.112	.011	S.
12	.7	1.57	.918	.092	.009	S.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
3	−173.737	+ 86.386	+0.333	0.78	+20° 1678	9.1
4	216.128	− 47.678	0.130	9.54		
10	+174.059	+ 91.434	0.423	0.61		
13	215.807	−130.144	0.114	0.55		
π	12.386	+ 46.326		0.76		

Normal equations:

$$9.800c + 0.246\mu - 0.355\pi = +1.032.$$
$$+16.806 \quad +2.146 \quad = +0.026.$$
$$+7.574 \quad = -0.011.$$

Solution:

$$\mu = -0''.002 \pm 0''.015.$$
$$c = +0 \ .105.$$
$$= +0''.017 \pm 0''.007.$$

p. e. unit weight $\pm 0''.019$.

B. D. + 21° 1528. Lalande 13849. $7^h 4^m.2$, + 21° 25′.)
Mag. 6.46. $\mu = -0^s.0120; -0''.482$. Spectrum F_8.

The measures are in longitude. Chase, with the heliometer, found a parallax for this star of +0″.10, and Adams found a hypothetical parallax of +0″.03.

TABLE 1.

No.	Date	Hour angle	Observer	No. of expo-sures	Quality of images	No. of inter-polations
		hr. min.				
1	Nov. 2, 1913	+0 56	P.	3	5	0
2	Nov. 6, 1913	0 42	P.	3	3	0
3	Dec. 9, 1913	0 45	P.	3	5	0
4	Feb. 26, 1914	+0 50	M.	2	5	0
5	Mar. 4, 1914	0 49	P.	3	5	1
6	Oct. 28, 1914	+0 25	M.	3	4	1
7	Nov. 2, 1914	0 50	M.	3	4	0
8	Nov. 9, 1914	1 0	M.	3	3	0
9	Feb. 10, 1915	+0 0	P.	3	5	0
10	Feb. 28, 1915	0 50	M.	3	3	1
11	Mar. 1, 1915	−0 15	P.	3	3	0
12	Mar. 12, 1915	+0 5	P.	3	5	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.9	−2.75	+0.897	+0.138	.005	H.
2	.8	2.71	.864	.133	.000	H.
3	.9	2.38	.454	.133	.006	H.
4	.8	−1.59	−0.786	.095	.020	H.
5	.9	1.53	.846	.118	.005	H.
6	1.0	+0.85	+0.933	.096	.003	H.
7	.9	0.90	.899	.095	.004	H.
8	.9	0.97	.839	.090	.007	H.
9	.9	+1.90	−0.583	.084	.001	H.
10	.9	2.08	.805	.088	.008	H.
11	.9	2.09	.815	.085	.005	H.
12	1.0	2.20	.910	.074	.004	H.

COMPARISON STARS.

No.	X	Y	Depend-ence	Diameter	B. D. No.	Mag-nitude.
3	+205.487	+ 57.995	+0.060	0.83		
5	−173.803	−183.690	0.256	0.84	+21 °1524	9.0
6	93.691	143.858	0.202	0.57		
11	+ 62.007	+269.551	0.482	0.61	+21° 1531	9.4
π	−21.132	57.263		0.76		

Normal equations:

$$10.800c + 0.762\mu + 0.120\pi = +1.101.$$
$$+40.121 \quad -6.689 \quad = -0.327.$$
$$+7.192 \quad = +0.105.$$

Solution: $\mu = -0''.044 \pm 0''.004.$
$c = +0\ .103.$
$\pi = +0''.019 \pm 0''.010.$

p. e. unit weight $\pm 0''.026$.

B. D. + 5° 1739. α Canis Minoris = Procyon. ($7^h34^m.1$, + 5°29′.)
Mag. 0.5 — 13.5. μ = — $0^s.0466$; — 1″.030. Spectrum F_5.

The measures were in longitude. The star was chosen because it is a binary, and because the parallaxes determined for it are discordant, but chiefly because we wished to see what we could do with stars as bright as Procyon. The occulting disk was set so that about 0.01 of the light of the star reached the plate.

Kapteyn, from Auwer's, Flint's and Elkins's measures, decided the absolute parallax of this star was +0″.324. Adams computed a hypothetical parallax of +0″.36 for it, and Russell a hypothetical parallax of +0″.265.

TABLE 1.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Feb. 23, 1913	+0 00	M.	3	2	1
2	Mar. 25, 1913	0 50	M.	2	2	0
3	Oct. 28, 1913	+0 0	P.	2	4	1
4	Dec. 4, 1913	0 12	P.	2	1	2
5	Mar. 12, 1914	+0 55	M.	3	5	1
6	Mar. 13, 1914	0 0	P.	2	5	1
7	Mar. 22, 1914	0 43	M.	3	5	1
8	Nov. 2, 1914	+1 0	M.	2	3	0
9	Nov. 11, 1914	1 0	M.	3	2	0
10	Nov. 17, 1914	−0 14	P.	3	5	1
11	Nov. 20, 1914	0 30	M.	2	3	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.9	−3.84	−0.640	+0.429	.006	P.
2	.7	3.54	.939	.392	.002	P.
3	.7	−1.37	+0.976	.389	.006	P.
4	.6	1.00	.659	.351	.005	P.
5	.9	−0.02	−0.834	.214	.001	P.
6	.7	0.01	.844	.206	.008	P.
7	.9	+0.08	.918	.207	.002	P.
8	.8	+2.33	+0.955	.214	.010	P.
9	.9	2.42	.900	.209	.013	P.
10	.9	2.48	.851	.184	.006	P.
11	.7	2.51	.823	.177	.009	P.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude.
2	− 175.441	− 20.185	+0.122	0.51		
3	131.243	32.073	0.146	0.42	+5° 1736	9.1
4	202.387	125.172	0.191	0.56		
6	+ 151.588	+ 36.117	0.191	1.54	+5° 1742	7.5
7	150.795	73.465	0.163	0.70	+5° 1743	9.1
8	206.690	67.845	0.187	0.58	+5° 1744	9.1
n	14.196	0.591		1.35		

Normal equations:

$$8.700c + 0.585\mu + 0.593\pi = +2.315.$$
$$+43.522 \quad +10.247 \quad = -1.450.$$
$$+\ 6.380 \quad = +0.022.$$

Solution:

$$\mu = -0''.241 \pm 0''.005.$$
$$c = +0\ .265.$$
$$\pi = +0''.287 \pm 0''.012.$$

p. e. unit weight $\pm 0''.024$.

B. D. + 2° 1854. 13 Canis Minoris ($7^h\ 57^m.1$, + 2° 36′.)
Mag. 4.52. $\mu = -0^s.0026; +0''.099$. Spectrum K.

The measures are in longitude. No other parallax of this star has been published.

TABLE I.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Nov. 5, 1913	+0 30	S.	3	5	0
2	Nov. 20, 1913	0 8	P.	3	5	0
3	Dec. 4, 1913	0 45	P.	3	5	0
4	Dec. 19, 1913	0 30	S.	2	3	0
5	Mar. 3, 1914	+1 0	M.	3	4	0
6	Mar. 20, 1914	0 40	P.	3	5	0
7	Mar. 22, 1914	1 15	M.	3	3	0
8	Nov. 13, 1914	+0 45	M.	3	4	0
9	Nov. 17, 1914	0 20	P.	3	5	0
10	Nov. 20, 1914	−0 5	M.	3	5	0
11	Feb. 10, 1915	+0 5	P.	.	5	0
12	Feb. 21, 1915	0 7	M.	3	2	0
13	Mar. 26, 1915	−0 15	P.	2	3	0
14	Mar. 27, 1915	+1 0	Ma.	2	3	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.9	−2.54	+0.968	−0.045	.003	P.
2	.8	2.39	.877	.052	.009	P.
3	1.0	2.25	.737	.035	.010	P.
4	.8	2.10	.539	.059	.011	P.
5	.9	−1.36	−0.659	.057	.004	P.
6	.9	1.19	.850	.063	.000	P.
7	.7	1.17	.859	.053	.010	P.
8	1.0	+1.19	+0.929	.058	.004	P.
9	1.0	1.23	.902	.062	.001	P.
10	.9	1.26	.879	.061	.002	P.
11	.8	+2.08	−0.342	.066	.011	P.
12	.8	2.19	.515	.080	.001	P.
13	.7	2.52	.898	.090	.006	P.
14	.8	2.53	.906	.092	.008	P.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
2	+254.050	− 90.326	+0.159	0.90	+2° 1862	8.6
5	−175.155	+200.254	0.254	0.62		
6	111.616	144.253	0.246	0.53	2° 1850	9.4
10	+ 32.720	−254.180	0.341	0.61	3° 1877	9.0
π	− 20.445	14.782		0.77		

Normal equations:

$$\begin{aligned} 12.000c - 0.484\mu + 1.364\pi &= -0.739. \\ +44.086 \quad -5.713 \quad &= -0.249. \\ +7.691 \quad &= +0.003. \end{aligned}$$

Solution:

$$\begin{aligned} \mu &= -0''.025 \pm 0''.003. \\ c &= -0\ \ .063. \\ \pi &= +0''.035 \pm 0''.008. \end{aligned}$$

p. e. unit weight $\pm 0.''022$.

B. D. + 12° 1759. β 581. ($7^h\ 58^m.8$, + 12° 35′.)
Mag. 8.7 − 8.7. $\mu = +\ 0.^s0053;\ -\ 0''.118$.

The measures are in longitude. This star is a close binary, the components of which are of the same magnitude. They are so close that it was impossible to separate their images on the plate. In fact, the combined image of the stars was not sensibly elongated. In the measurement the combined image of the parallax star was bisected. No other parallax of this star has been published.

TABLE 1.

No.	Date	Hour angle	Observer	No. of expo-sures	Quality of images	No. of inter-polations
		hr. min.				
1	Mar. 4, 1915	+0 12	M.	2	4	0
2	Mar. 8, 1915	−0 6	P.	3	4	0
3	Mar. 12, 1915	+0 0	P.	3	1	0
4	Oct. 24, 1915	+0 15	P.	3	3	3
5	Nov. 13, 1915	0 20	M.	2	4	1
6	Nov. 27, 1915	1 0	M.	3	4	0
7	Dec. 4, 1915	−0 20	M.	3	3	0
8	Dec. 10, 1915	+0 15	Ma.	2	4	0
9	Dec. 14, 1915	0 10	P.	3	3	0
10	Mar. 4, 1916	+1 3	Ma.	2	2–3	1
11	Mar. 9, 1916	0 40	S.	3	4	0
12	Mar. 11, 1916	0 31	Ma.	3	3	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.9	−2.27	−0.690	+0.165	.006	S.
2	.9	2.23	.737	.175	.004	S.
3	.7	2.19	.783	.172	.001	S.
4	.8	+0.07	+0.994	.227	.006	S.
5	.9	0.27	.920	.245	.100	S.
6	.9	0.41	.800	.226	.009	S.
7	.9	0.48	.721	.242	.007	S.
8	1.0	0.54	.646	.233	.001	S.
9	.8	0.58	.593	.226	.007	S.
10	.7	+1.39	−0.698	.220	.002	S.
11	1.0	1.44	.758	.228	.006	S.
12	.9	1.46	.780	.215	.006	S.

COMPARISON STARS.

No.	*X*	*Y*	Depend-ence	Diameter	B. D. No.	Mag-nitude
4	+177.112	− 52.255	+0.108	0.71		
6	262.245	+ 46.985	0.348	0.62		
13	−196.042	52.371	0.394	0.70	+12° 1753	9.3
15	−243.314	− 47.103	0.150	0.51		
π	−3.122	+ 24.255		0.89		

Normal equations:

$$10.400c + 0.248\mu + 0.331\pi = 2.241.$$
$$+18.804 \quad +2.803 \quad = 0.364.$$
$$+6.104 \quad = 0.217.$$

Solution:

$$\mu = +0''.065 \pm 0''.005.$$
$$c = +0\ .215.$$
$$\pi = +0''.082 \pm 0''.009.$$

p. e. unit weight $\pm 0''.021$.

B. D. + 18° 1867. ζ Cancri = Σ 1196. (8^h 6^m. 5, + 17° 57′.)
Mag. 6.02. $\mu = + 0^s.0046—0''.140$. Spectrum F.

This is a wide visual double star, consisting of a large component *A* and a slightly fainter component *BC*. The latter is a binary with a period of 60.083 years. The combined image of the components of *BC* is sensibly round, and in the measures was bisected. The same set of plates and the same comparison stars were used for the *A*- and the *BC*-components, and the observational data for both are found in Table 1. Table 2 contains the solution for the *A*-component, and Table 3 the solution for the *BC*-component.

Russell finds a hypothetical parallax for the *BC*-component of + 0″.045.

TABLE 1.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Nov. 1, 1913	+0 20	M.	2	3	0
2	Nov. 4, 1913	0 37	P.	3	5	0
3	Nov. 17, 1913	0 45	M.	3	4	0
4	Nov. 20, 1913	0 50	P.	3	5	1
5	Dec. 9, 1913	0 40	P.	2	3	0
6	Mar. 12, 1914	+1 20	M.	3	5	0
7	Mar. 13, 1914	0 15	P.	3	3	0
8	Apr. 5, 1914	0 55	S.	2	2	0
9	Apr. 9, 1914	1 10	M.	2	5	0
10	Apr. 10, 1914	1 20	S.	3	5	0
11	Apr. 12, 1914	1 20	M.	3	4	0
12	Nov. 13, 1914	+1 10	M.	2	2	1
13	Nov. 20, 1914	0 55	M.	2	3	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.8	−1.34	+0.979	−0.128	.003	S.
2	.9	1.31	.968	.112	.012	S.
3	.7	1.18	.893	.132	.008	M.
4	.9	1.15	.869	.125	.000	M.
5	.7	0.96	.664	.128	.003	M.
6	.9	−0.03	−0.779	.124	.006	S.
7	.9	0.02	.790	.128	.002	S.
8	.8	+0.21	.968	.136	.006	S.
9	.7	0.25	.984	.124	.006	M.
10	.9	0.26	.988	.131	.001	S.
11	.7	0.28	.994	.134	.004	M.
12	.6	+2.43	+0.923	.116	.007	M.
13	.7	2.50	.871	.101	.008	M.

COMPARISON STARS FOR BOTH COMPONENTS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
1	− 3.510	+118.206	0.234	0.25		
2	159.652	70.254	0.182	0.33	+18° 1864	9.5
3	222.282	− 1.988	0.131	0.39	1863	9.5
4	+ 52.489	+ 30.787	0.193	0.55	1870	9.1
5	133.446	− 29.932	0.170	0.29	1874	9.5
7	199.506	187.330	0.090	0.51	1877	9.3
π	− 8.335	+ 24.256		0.54		

Normal equations:

$$10.200c - 0.843\mu + 0.230\pi = -1.274.$$
$$+13.905 \quad -2.129 \quad = +0.149.$$
$$+8.304 \quad = +0.015.$$

Solution:

$$\mu = +0''.019 \pm 0''.005.$$
$$c = -0\ .125.$$
$$\pi = +0''.030 \pm 0''.007.$$

p. e. unit weight $\pm 0''.019$.

TABLE 3.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.7	Same as Table 2	Same as Table 2	+0.050	.012	Same as Table 2
2	.9	Same as Table 2	Same as Table 2	.038	.000	Same as Table 2
3	.7	Same as Table 2	Same as Table 2	.035	.004	Same as Table 2
4	.7	Same as Table 2	Same as Table 2	.045	.006	Same as Table 2
5	.7	Same as Table 2	Same as Table 2	.031	.008	Same as Table 2
6	.9	Same as Table 2	Same as Table 2	.026	.010	Same as Table 2
7	.9	Same as Table 2	Same as Table 2	.047	.011	Same as Table 2
8	.7	Same as Table 2	Same as Table 2	.032	.005	Same as Table 2
9	.8	Same as Table 2	Same as Table 2	.020	.017	Same as Table 2
10	.9	Same as Table 2	Same as Table 2	.049	.012	Same as Table 2
11	.9	Same as Table 2	Same as Table 2	.045	.008	Same as Table 2
12	.6	Same as Table 2	Same as Table 2	.059	.010	Same as Table 2
13	.7	Same as Table 2	Same as Table 2	.078	.009	Same as Table 2

Normal equations:

$$10.100c - 0.424\mu - 0.243\pi = 0.422.$$
$$+13.478 \quad -1.857 \quad = 0.079.$$
$$+8.258 \quad = 0.036.$$

Solution:

$$\mu = +0''.039 \pm 0''.008.$$
$$c = +0\ .042.$$
$$\pi = +0''.035 \pm 0''.011$$

p. e. unit weight $\pm 0''.030$.

B. D. $-12°$ 2449. Lalande 16304. (8^h $13^m.7$, $-12°$ $18'$.)
Mag. 6.04. $\mu = +0^s.0191; -0''.991$. Spectrum F.

The measurements are in longitude.

Chase obtained for this star a parallax of $0''.095$ and Flint a parallax of $0''.12$.

TABLE 1.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Mar. 5, 1913	+0 30	B.	3	1	2
2	Mar. 22, 1913	0 10	M.	3	1	0
3	Nov. 24, 1913	+1 10	M.	3	1	2
4	Dec. 5, 1933	0 40	S.	3	1	1
5	Dec. 29, 1913	0 45	P.	3	2	0
6	Mar. 13, 1914	+0 52	P.	3	5	1
7	Apr. 5, 1914	1 7	S.	3	5	0
8	Mar. 1, 1915	−0 42	P.	3	2	0
9	Apr. 15, 1915	+1 30	M.	3	3	2
10	Nov. 24, 1915	+2 0	M.	3	3	1
11	Nov. 29, 1915	0 40	S.	3	3	0
12	Dec. 4, 1915	0 30	M.	3	3	1

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.6	−5.10	−0.412	−0.326	.001	S.
2	.5	4.93	.659	.324	.002	H.
3	1.0	−2.46	+0.965	.223	.004	S.
4	.7	2.35	.905	.237	.012	S.
5	.8	2.11	.663	.214	.006	S.
6	1.0	−1.37	−0.531	.222	.004	S.
7	1.0	1.14	.820	.212	.004	S.
8	.8	+2.16	−0.338	.113	.003	S.
9	.9	2.61	.906	.107	.001	S.
10	.8	+4.84	+0.954	.014	.003	S.
11	.8	4.89	.944	.005	.004	S.
12	.8	4.94	.915	.006	.002	S.

COMPARISON STARS FOR BOTH COMPONENTS.

No.	*X*	*Y*	Dependence	Diameter	B. D. No.	Magnitude
1	+298.764	+118.099	0.239	0.62	−12° 2454	10.0
2	297.190	−103.739	0.198	0.49		
3	−146.182	146.354	0.165	0.57		
4	248.829	+ 41.636	0.193	0.64	12° 2436	9.0
6	200.941	90.356	0.205	0.50	12° 2437	9.5
π	+ 16.687	10.153		0.63		

Normal equations:

$$9.700c + 1.985\mu + 1.366\pi = -1.558.$$
$$+111.671 \quad +7.855 \quad = +3.097.$$
$$+6.071 \quad = +0.099.$$

Solution:
$$\mu = +0''.139 \pm 0''.002.$$
$$c = -0\ .169.$$
$$\pi = +0''.075 \pm 0''.007.$$

p. e. unit weight $\pm 0''.017$.

B. D. + 42° 1956. 10 Ursæ Majoris ($8^h\ 54^m.2$, = 42° 11′.)
Mag. 409. $\mu = -\ 0^s.0388;\ -\ 0''.261$. Spectrum F_5.

The measures are in longitude. This star has a large proper motion. Other parallaxes published for it are:

Flint (Transits) .... —0″.004
Belopolsky (Transits) .... +0″.020
Chase (Heliometer) .... +0″.08
Adams (Hypothetical) .... +0″.11

TABLE 1.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Nov. 26, 1912	−0 6	B.	3	2	0
2	Dec. 9, 1912	+0 0	M.	3	2	1
3	Dec. 13, 1912	0 0	M.	2	3	0
4	Dec. 15, 1912	−0 24	B.	3	2	0
5	Mar. 1, 1915	+0 2	P.	2	3	0
6	Apr. 1, 1915	0 0	M.	2	2	1
7	Apr. 4, 1915	0 5	P.	2	2	0
8	Apr. 8, 1915	0 20	M.	2	2	0
9	Dec. 30, 1915	+0 15	P.	2	3	0
10	Jan. 3, 1916	0 15	S.	2	3	0
11	Mar. 9, 1916	+0 15	S.	3	3	1
12	Mar. 11, 1916	0 22	Ma.	3	3	1

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.7	−6.76	+0.848	+0.026	.001	M.
2	.6	6.63	.710	.034	.012	M.
3	.7	6.59	.660	.009	.011	M.
4	.8	6.57	.633	.014	.006	M.
5	.8	+1.49	−0.588	−0.139	.012	M.
6	.9	1.80	.921	.166	.003	M.
7	.9	1.83	.941	.157	.007	M.
8	.7	1.87	.963	.163	.002	M.
9	.9	+4.53	+0.422	.184	.004	M.
10	.9	4.57	.357	.188	.002	M.
11	.9	+5.23	−0.703	.230	.008	M.
12	.9	5.25	.727	.234	.012	M.

COMPARISON STARS

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
4	+114.235	+100.983	0.169	0.41		
5	− 99.208	9.905	0.237	0.73	+42° 1953	9.3
7	220.617	25.200	0.219	0.48	+42° 1952	9.4
9	+205.590	−136.088	0.375	0.41		
π	24.503	26.067		0.54		

Normal equations:

$$9.700c + 4.811\mu - 1.418\pi = -1.213.$$
$$+220.137 \quad -21.767 \quad = -4.985.$$
$$+\ 5.112 \quad = +0.654.$$

Solution:
$\mu = -0''.086 \quad \pm 0''.002.$
$c = -0\ .113.$
$\pi = +0''.086 \quad \pm 0''.015.$

p. e. unit weight $\pm 0''.025$.

B. D. $+29°$ 1883. Lalande 18286 = Σ3121. (9^h $12^m.0$, $+29°$ $0'$.)
Mag. 7.6 – 7.9 $\mu = +0^s.0053; -0''.512$.

The measures were in longitude. The star is a visual binary with a period of 34.00 years. The combined image of the components is not sensibly elongated.

Flint (Transits) found a parallax of $+0''.119$; Chase (Heliometer) found a parallax of $0''.000$.

TABLE 1.

No.	Date	Hour angle	Observer	No. of expo-sures	Quality of images	No. of inter-polations
		hr. min.				
1	Nov. 29, 1912	+0 0	M.	3	3	0
2	Dec. 13, 1912	0 30	M.	3	3	0
3	Dec. 11, 1913	+0 25	P.	3	5	2
4	Dec. 19, 1913	0 5	S.	3	5	0
5	Apr. 12, 1914	+1 15	M.	3	5	0
6	Jan. 4, 1915	+0 45	M.	2	5	0
7	Jan. 8, 1915	0 55	M.	3	5	0
8	Mar. 14, 1915	+0 40	M.	3	5	0
9	Mar. 16, 1915	0 15	M.	3	5	0
10	Mar. 27, 1915	1 30	Ma.	3	4	0
11	Apr. 4, 1915	0 34	P.	3	5	0
12	Apr. 7, 1915	0 45	P.	3	5	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.8	−5.87	+0.887	−0.238	.000	H.
2	.8	5.73	.752	.240	.000	H.
3	.9	−2.10	+0.777	.193	.000	S.
4	1.0	2.02	.683	.206	.012	H.
5	.8	−0.88	−0.944	.194	.013	H.
6	.7	+1.79	+0.459	.141	.009	H.
7	.9	1.83	.395	.141	.009	H.
8	1.0	+2.48	−0.658	.168	.008	S.
7	.9	2.50	.684	.165	.005	H.
10	.7	2.61	.812	.168	.008	S.
11	.9	2.69	.886	.159	.002	H.
12	.9	2.72	.908	.159	.002	H.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
1	−283.972	+ 58.771	0.330	0.42	+29° 1881	9.5
2	+187.830	−190.084	0.250	0.40		
5	78.080	+ 88.726	0.191	0.38		
6	18.060	42.587	0.229	0.54	+29° 1884	9.2
π	− 27.891	− 1.372		0.48		

Normal equations:

$$10.300c + 0.432\mu - 0.840\pi = -1.864.$$
$$+97.472 \quad -17.596 \quad = +0.851.$$
$$+ 5.856 \quad = +0.028.$$

Solution:

$$\mu = +0''.059 \quad \pm 0''.004.$$
$$c = -0\ .180.$$
$$\pi = +0''.078 \quad \pm 0''.015.$$

p. e. unit weight $\pm 0''.025$.

B. D. + 9° 2882. Σ 1835 (β1111.) ($14^h 18^m.5$, + 8°54′.)
Mag. 5.11 − 6.64. $\mu = -0^s.0046$; $-0''.025$. Spectrum A.

The measures were made in longitude. The fainter component of the Struve pair is β1111, which is a binary having a period of 44.32 years. No other determinations have been published.

TABLE 1. (β1111)

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Feb. 19, 1915	+0 20	M.	3	4	2
2	Feb. 20, 1915	0 25	P.	3	5	0
3	Mar. 3, 1915	1 20	Ma.	1	2	1
4	June 4, 1915	+0 10	P.	3	5	1
5	June 5, 1915	0 15	Ma.	3	4	0
6	June 9, 1915	0 26	P.	3	3	0
7	June 24, 1915	0 36	Ma.	3	3	0
8	July 10, 1915	1 30	Ma.	2	3	0
9	Feb. 7, 1916	+0 35	S.	3	3	1
10	Mar. 23, 1916	0 18	P.	2	2	0
11	June 12, 1916	+0 25	P.	2	3	0
12	June 22, 1916	1 25	S.	3	3	1

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.9	−1.93	+0.844	+0.208	.002	S.
2	1.0	1.92	.835	.199	.007	S.
3	.5	1.81	.721	.211	.005	S.
4	1.0	−0.88	−0.704	.202	.007	S.
5	.9	0.87	.715	.194	.001	S.
6	.8	0.83	.762	.193	.002	S.
7	.8	0.68	.906	.184	.009	S.
8	.7	0.52	.996	.198	.006	S.
9	.8	+1.60	+0.932	.187	.004	S.
10	.7	2.05	.435	.176	.002	S.
11	.8	+2.86	−0.802	.163	.006	S.
12	.9	2.96	.896	.170	.003	S.

COMPARISON STARS. (β1111)

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
1	−142.421	+130.003	+0.253	0.56	+8° 2852	9.1
4	+211.316	103.157	.153	0.34		
7	103.471	−177.184	.274	0.41	+9° 2884	9.3
10	−172.368	55.975	.320	0.34		
π	− 30.328	17.742		0.49		

Normal equations:

$$+9.800c - 0.130\mu - 1.821\pi = +1.865.$$
$$+30.662 \quad -3.585'' = -0.248$$
$$+6.436'' = -0.304$$

Solution:

$$\mu = -0''.033 \pm 0''.003.$$
$$c = +0\ .191.$$
$$\pi = +0''.013 \pm 0''.007.$$

p. e. unit weight $\pm 0''.017$.

TABLE 1. (Σ1835)

No.	Date	Hour angle (hr. min.)	Observer	No. of exposures	Quality of images	No. of interpolations
1	Feb. 19, 1915	+0 20	M.	3	4	2
2	Feb. 20, 1915	0 25	P.	3	5	0
3	Mar. 3, 1915	1 20	Ma.	3	2	0
4	June 4, 1915	+0 10	P.	3	5	1
5	June 5, 1915	0 15	Ma.	3	4	0
6	June 9, 1915	0 26	P.	3	3	0
7	June 24, 1915	0 36	Ma.	3	3	0
8	July 10, 1915	1 30	Ma.	2	3	0
9	Feb. 7, 1916	+0 35	S.	3	3	1
10	Mar. 23, 1916	0 18	P.	2	2	0
11	June 12, 1916	+0 25	P.	2	3	0
12	June 22, 1916	1 25	S.	3	3	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.9	−1.93	+0.844	+0.026	.001	S.
2	1.0	1.92	0.835	.025	.000	S.
3	.5	1.81	0.721	.026	.001	S.
4	.7	−0.88	−0.704	.012	.002	S.
5	.9	+0.87	0.715	.005	.009	S.
6	.8	0.83	0.762	.017	.003	S.
7	.8	0.68	0.906	.016	.003	S.
8	.7	0.52	0.996	.019	.007	S.
9	.8	+1.60	+0.932	.004	.003	S.
10	.7	2.05	0.435	−.006	.003	S.
11	.8	+2.86	−0.802	−.012	.000	S.
12	.9	2.96	0.896	.013	.000	S.

COMPARISON STARS. (Σ1835)

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
1	−142.421	+130.003	+0.255	0.56	+8° 2852	9.1
4	+211.316	103.157	.156	0.34		
7	103.471	−177.184	.271	0.41	9° 2884	9.3
10	−172.368	55.975	.318	0.34		
π'	30.124	16.434		0.49		

Normal equations:

$$+9.500c + 0.134\mu - 1.610\pi = +0.091.$$
$$30.429 \quad -3.772 \quad = -0.220.$$
$$+6.287 \quad = +0.025.$$

Solution:

$$\mu = +0''.033 \pm 0''.002.$$
$$c = +0\ .010.$$
$$\pi = +0''.011 \pm 0''.005.$$

p. e. unit weight $\pm 0''.012$.

B. D. + 41° 2076. Bradley 1433. ($10^h\ 16^m.3$, + 41° 44′.)
Mag. 5.88. $\mu = -0^s.0109; -0''.150$. Spectrum G.

The measures were made in longitude. Another parallax is by Jost. He obtains the value $+0''.10$. The hypothetical parallax computed by Adams is $0''.05$.

TABLE I.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Nov. 29, 1912	+0 0	S.	2	3	0
2	Dec. 9, 1912	0 0	S.	3	2	0
3	Dec. 12, 1912	−0 6	B.	2	2	0
4	Jan. 14, 1913	+0 12	B.	2	3	1
5	Apr. 19, 1913	−0 10	M.	3	2	0
6	Apr. 21, 1913	0 12	B.	2	2	0
7	Apr. 25, 1913	0 24	B.	3	5	1
8	Dec. 4, 1913	−0 15	P.	2	2	0
9	Dec. 5, 1913	0 25	S.	2	5	1
10	Dec. 11, 1913	0 7	P.	3	5	0
11	Dec. 19, 1913	0 20	S.	3	2	0
11	Dec. 30, 1913	+0 4	P.	3	5	0
13	Jan. 5, 1914	0 20	M.	3	2	0
14	Mar. 20, 1914	−0 30	P.	3	3	0
15	Mar. 22, 1914	0 20	M.	3	2	0
16	Apr. 12, 1914	+0 15	M.	3	5	0
17	Apr. 17, 1914	0 15	P.	3	5	0
18	Apr. 18, 1914	−0 10	S.	1	3	0
19	Apr. 23, 1914	+0 20	M.	2	5	0
20	May 2, 1914	0 17	M.	3	5	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.8	−2.75	+0.939	−2.164	.008	S.
2	.9	2.65	.870	2.163	.006	S.
3	.7	2.62	.844	2.171	.013	S.
4	.7	2.29	.422	2.165	.000	M.
5	7	−1.34	− .940	2.177	.012	M.
6	.7	1.32	.952	2.182	.007	M.
7	.7	1.28	.973	2.186	.004	M.
8	.8	+0.94	+0.909	2.160	.001	S.
9	.8	0.95	.902	2.156	.004	S.
10	.7	1.01	.855	2.155	.005	M.
11	.9	1.09	.777	2.158	.004	M.
12	.9	1.20	.644	2.153	.011	S.
13	1.0	1.26	.561	2.165	.000	S.
14	.7	+2.00	− .636	2.200	.014	Mt.
15	.4	2.02	.662	2.202	.016	M.
16	.5	2.23	.888	2.192	.001	M.
17	1.0	2.28	.926	2.191	.001	S.
18	.2	2.29	.932	2.195	.003	S.
19	.7	2.34	.962	2.200	.008	S.
20	.7	2.43	.998	2.199	.006	M.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
1	+260.046	−113.604	+0.33	0.68	+41° 2078	8.7
2	−166.131	+102.409	−0.33	0.66	41° 2072	8.0
3	93.915	11.195	+1.00	0.47	41° 2073	8.5
π	+ 44.560	− 59.227		0.41		

Normal equations:

$$51.720\mu + 4.156c - 7.820\pi = - 9.209.$$
$$+14.508 + 0.662 = -31.537.$$
$$+10.209 = - 1.259.$$

Solution :

$$\mu = -0''.003 \quad +0''.003.$$
$$c = -2\ .174.$$
$$\pi = +0''.080 \quad \pm 0''.007.$$

p. e. unit weight $\pm 0''.022$.

B. D. + 56° 1459. 36 Ursæ Majoris. ($10^h\ 24^m.2$, + 56° 30′.)
Mag. 4.84. $\mu = -0^s.0215; -0''.038$. Spectrum F.

The measures were made in longitude. This star has large proper motion. The field of the comparison stars by which the parallax was computed was chosen by the method described on page 10. The field chosen in this way consisted of stars numbered 2, 4, 5, and 7. Before the measures were made to determine the

final field, I chose in the usual way a field which consisted of stars numbered 4, 5, 6, and 7. Both fields were measured at the same time and a parallax found from each of them. Observational data are given in Table 1. The reduction for the field 2, 4, 5, and 7 is given in Table 2, which is followed by the normal equations and the solution for this field. Table 3 gives the reduction for the field 4, 5, 6, and 7. Following Table 3 are the normal equations and the solution for this second field.

No other parallax of this star has been published.

TABLE 1.

No.	Date	Hour angle	Observer	No. of expo-sures	Quality of images	No. of inter-polations
		hr. min.				
1	Apr. 4, 1915	+0 25	P.	2	4	0
2	Apr. 6, 1915	0 20	M.	2	4	0
3	Apr. 15, 1915	0 20	M.	3	3	0
4	Nov. 29, 1915	−0 20	S.	1	3	0
5	Dec. 4, 1915	0 20	M.	2	3	0
6	Dec. 10, 1915	0 6	Ma.	2	2	0
7	Dec. 22, 1915	0 50	M.	1	2	0
8	Dec. 23, 1915	+0 0	P.	1	2	0
9	Jan. 8, 1916	0 20	M.	2	3	0
10	Mar. 31, 1916	−0 3	P.	3	3	0
11	Apr. 18, 1916	+0 20	M.	3	2	0
12	Apr. 29, 1916	0 28	Ma.	2	2	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.8	−2.24	−0.873	−0.120	.002	M.
2	.8	2.22	.890	.130	.007	M.
3	.8	2.13	.952	.120	.004	M.
4	.7	+0.15	+0.902	.091	.001	M.
5	.9	0.20	.863	.088	.004	M.
6	.7	0.26	.807	.095	.002	M.
7	.6	0.38	.668	.080	.016	M.
8	.6	0.39	.655	.103	.006	M.
9	.8	0.55	.424	.118	.015	M.
10	.8	+1.38	−0.844	.121	.012	M.
11	.8	1.56	.972	.132	.004	M.
12	.7	1.67	1.004	.152	.015	M.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
2	−108.617	+223.714	+0.405	0.36		
4	119.335	−222.742	0.270	0.32		
5	+ 78.227	147.303	0.143	0.29		
7	149.724	+146.332	0.182	0.40		
π	− 37.922	36.138		0.77		

Normal equations:

$$9.000c - 0.382\mu - 1.222\pi = -1.019.$$
$$+17.528 \quad +2.338 \quad = +0.037.$$
$$+6.365 \quad = +0.267.$$

Solution:

$$\mu = -0''.015 \pm 0''.007.$$
$$c = -0\ .110.$$
$$\pi = +0''.103 \pm 0''.012.$$

p. e. unit weight $\pm 0.''028$.

TABLE 3.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	Same as Table 2		Same as Table 2	+0.044	.002	Same as Table 2
2	Same as Table 2		Same as Table 2	.026	.016	Same as Table 2
3	Same as Table 2		Same as Table 2	.055	.014	Same as Table 2
4	Same as Table 2		Same as Table 2	.075	.001	Same as Table 2
5	Same as Table 2		Same as Table 2	.072	.002	Same as Table 2
6	Same as Table 2		Same as Table 2	.067	.006	Same as Table 2
7	Same as Table 2		Same as Table 2	.087	.017	Same as Table 2
8	Same as Table 2		Same as Table 2	.070	.000	Same as Table 2
9	Same as Table 2		Same as Table 2	.055	.009	Same as Table 2
10	Same as Table 2		Same as Table 2	.052	.012	Same as Table 2
11	Same as Table 2		Same as Table 2	.036	.001	Same as Table 2
12	Same as Table 2		Same as Table 2	.025	.011	Same as Table2

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
4	−111.901	−225.893	+0.254	0.32		
5	+ 85.661	150.454	0.170	0.29		
6	−130.917	+233.165	0.372	0.42		
7	+157.158	143.181	0.204	0.40		
π	− 30.488	32.987		0.77		

Normal solutions:

$$8.900c - 0.402\mu - 1.309\pi = 0.485.$$
$$17.524\mu + 2.321 \quad = 0.005.$$
$$6.290 \quad = 0.044.$$

Solution:

$$\mu = -0''.004 \pm 0''.007.$$
$$c = +0\ 057.$$
$$\pi = +0''.090 \pm 0''.013.$$

p. e. unit weight $\pm 0''.030$.

B.D. + 36° 2147. Lalande 21185. ($10^h 57^m.9$, + 36° 38′.)
Mag. 7.8. $\mu = -0^s.0469; -4''.746$.

The measures are in longitude. This star has a large proper motion. Kapteyn computed an absolute parallax from the measures of Winnecke, Kapteyn, Flint, Jost, Russell, and Chase to be + 0″.403. The smallest parallax given by the authorities cited is that of Russell, whose value is + 0″.350, and the largest that derived by Winnecke, which is + 0″.507.

TABLE 1.

No.	Date	Hour angle	Observer	No. of expo-sures	Quality of images	No. of inter-polations
		hr. min.				
1	Apr. 25, 1912	+0 0	M.	2	1	0
2	Apr. 27, 1912	0 24	B.	2	3	0
3	May 4, 1912	0 12	B.	3	1	0
4	Dec. 9, 1912	+0 0	M.	2	5–1	0
5	Apr. 19, 1913	+0 0	M.	3	2	0
6	Apr. 21, 1913	0 12	B.	3	5	0
7	Apr. 25, 1913	−0 24	B.	2	4	1
8	May 8, 1913	+0 0	M.	2	5	2
9	Dec. 4, 1913	+0 0	P.	3	4	1
10	Dec. 5, 1913	−0 10	S.	3	5	1
11	Dec. 11, 1913	+0 3	P.	3	4	0
12	Dec. 19, 1913	−0 20	S.	3	5	0
13	Dec. 30, 1913	+0 29	P.	3	4	2
14	Jan. 5, 1914	0 20	M.	2	3	1

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.7	−2.51	−0.910	+2.225	.011	S.
2	.7	2.49	.924	2.211	.003	S.
3	.7	2.42	.964	2.215	.001	S.
4	.6	−0.23	+0.941	2.519	.003	S.
5	.9	+1.08	−0.857	2.440	.005	S.
6	.9	1.10	.875	2.435	.001	S.
7	.8	1.14	.907	2.422	.012	S.
8	.7	1.27	.984	2.442	.007	S.
9	.9	+3.37	+0.964	2.744	.003	S.
10	.9	3.38	.960	2.745	.003	S.
11	.9	3.44	.931	2.755	.012	S.
12	1.0	3.52	.876	2.739	.003	S.
13	.9	3.63	.772	2.735	.004	S.
14	.8	3.69	.703	2.732	.005	S.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
1	−122.499	−151.717	0.23	0.78	+37° 2151	7.7
2	141.130	84.550	0.22	0.51	37° 2149	9.3
3	96.488	+251.938	0.19	0.48		
7	+360.115	− 15.671	0.36	0.58		
π	54.532	11.908		0.54		

Normal equations:

$$83.522\mu + 17.343c + 17.734\pi = 49.154.$$
$$+11.409 + 0.333 = 29.020.$$
$$+ 9.197 = 2.735.$$

Solution:

$$\mu = +0''.283 \pm 0''.004.$$
$$c = +2\ .449.$$
$$\pi = +0''.443 \pm 0''.010.$$

p. e. unit weight $\pm 0''.020$.

B. D. + 61° 1246. OΣ 235. ($11^h\ 26^m.7$, + 61° 38′.)
Mag. 5.47. $\mu = -0^s.0005; -0''.079$. Spectrum F.

The measures are in right ascension. This is a binary star with a period of 71.9 years. The components are sufficiently near the same magnitude and close enough together so that the combined image of the components is not sensibly elongated.

Russell finds a hypothetical parallax of 0″.032.

Table I.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Feb. 1, 1914	+0 0	P.	3	4	0
2	Feb. 2, 1914	−0 6	M.	3	2	0
3	May 2, 1914	−0 5	M.	3	1	0
4	Jan. 4, 1915	+0 10	M.	3	2	1
5	Jan. 14, 1915	−0 15	M.	2	3	0
6	Jan. 29, 1915	+0 15	M.	3	1	0
7	Feb. 18, 1915	0 28	P.	3	4	0
8	Apr. 6, 1915	−0 5	M.	3	3	0
9	Apr. 7, 1915	0 47	P.	3	5	0
10	Apr. 15, 1815	+0 20	M.	2	4	0
11	Apr. 17, 1915	0 15	Ma.	3	4	0
12	Apr. 18, 1915	−0 20	M.	2	4	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.9	−3.08	+0.56	+0.155	.002	S.
2	.8	3.07	.55	.160	.003	S.
3	.8	−2.18	−0.72	.148	.001	S.
4	.8	+0.29	+0.83	.167	.008	S.
5	.6	0.39	.76	.189	.014	S.
6	.8	0.54	.61	.170	.004	S.
7	.9	0.74	.32	.174	.003	S.
8	.9	+1.21	−0.39	.164	.002	S.
9	1.0	1.22	.40	.159	.007	S.
10	1.0	1.30	.53	.163	.002	S.
11	.8	1.32	.54	.179	.014	S.
12	1.0	1.33	.55	.163	.002	S.

COMPARISON STARS.

No.	*X*	*Y*	Dependence	Diameter	B. D. No.	Magnitude
2	−113.921	−201.247	0.479	0.30	+61° 1248	9.4
3	+ 12.835	+207.606	0.275	0.39	62 1186	9.5
4	71.386	206.555	0.129	0.41	62 1187	9.4
5	29.700	−212.914	0.117	0.36		
π	− 38.426	37.820		0.60		

Normal equations:

$$10.300c + 0.587\mu + 0.001\pi = 1.702.$$
$$+28.423 \quad -3.704 \quad = 0.182.$$
$$+3.340 \quad = 0.020.$$

Solution:

$$\mu = +0''.021 \pm 0''.004.$$
$$c = +0\ .165.$$
$$\pi = +0''.051 \pm 0''.013.$$

p. e. unit weight $\pm 0''.022$.

B. D. + 15° 2383. β Leonis = β 604. ($11^h 44^m.0$, + 15° 8′.)
Mag. 2.23. $\mu = -0^s.0342; -0''.123$. Spectrum A_2.

The measures were made in longitude. The quality of these plates was not good, and the magnitude of the comparison stars unequal. Parallaxes of this star published by Pritchard, Chase, and Flint are as follows:

Pritchard (Photography)	0″.0490
Chase (Heliometer)	0″.12
Flint (Transits)	0″.031

TABLE I.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	May 4, 1912	+1 6	B.	3	2	1
2	May 19, 1912	0 30	B.	3	3	1
3	Jan. 14, 1913	−0 24	B.	3	4	0
4	Feb. 7, 1913	+0 30	M.	2	2	0
5	Feb. 13, 1913	0 24	B.	3	3	1
6	Feb. 14, 1913	1 0	M.	3	3	0
7	Apr. 25, 1913	−0 24	B,	3	4	1
8	May 14, 1913	0 12	B.	3	5	0
9	May 19, 1913	+0 18	B.	3	5	1
10	Dec. 11, 1913	+0 7	P.	2	3	2
11	Jan. 5, 1914	0 20	M.	3	3	2
12	Feb. 1, 1914	0 38	P.	3	5	1
13	Feb. 2, 1914	1 0	M.	2	3	0
14	Apr. 17, 1914	+0 30	P.	3	5	0
15	Apr. 30, 1914	0 20	M.	3	4	0
16	May 14, 1914	0 20	M.	3	3	1

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.7	−3.62	−0.809	−2.493	.017	S.
2	1.0	3.47	.940	2.514	.003	S.
3	.7	−1.07	+0.813	2.556	.017	M.
4	.6	0.83	.514	2.564	.011	M.
5	.7	.77	.415	2.553	.014	M.
6	.7	.76	.399	2.552	.015	M.
7	.9	−0.06	−0.711	2.621	.017	M.
8	.9	+0.13	.905	2.625	.011	M.
9	.7	.18	.942	2.617	.001	M.
10	.8	+2.24	+0.984	2.632	.007	M.
11	.7	2.54	.893	2.631	.004	M.
12	.8	2.76	.604	2.642	.006	M.
13	.7	2.77	.590	2.630	.018	M.
14	.9	+3.51	−0.602	2.690	.008	S.
15	.9	3.64	.766	2.713	.008	S.
16	.7	3.78	.901	2.710	.002	M.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
1	−183.755	− 54.730	0.26	0.42		
2	46.221	+116.326	0.14	0.56		
3	3.133	42.816	0.17	0.83	+15° 2822	8.2
4	+ 97.569	− 65.944	0.23	0.59		
5	135.542	38.470	0.20	0.40		
π	− 2.639	13.468		0.61		

Normal equations:

$$76.326\mu + 8.666c + 2.855\pi = +24.415.$$
$$+12.411 \quad -1.731 = +32.391.$$
$$+7.301 = -\ 4.582.$$

Solution:

$$\mu = -0''.127 \pm 0''.004.$$
$$c = -2\ .588.$$
$$\pi = +0''.116 \pm 0''.013.$$

p. e. unit weight $\pm 0''.035$.

B. D. + 11° 2589. Lalande 25224 − β 612. ($13^h\ 34^m.7$, + 11° 15′.)
Mag. 5.54. $\mu = -0^s.0076; -0''.011$. Spectrum A.

The measures are made in longitude. This is a binary star with a period of 23.05 years. The components are of the same magnitude and so close that their combined image, if at all long, is very slightly so. The combined image was bisected in making the measurements.

Flint published a parallax of + 0″.25 and Russell a hypothetical parallax of 0″.021.

TABLE 1.

No.	Date	Hour angle *hr. min.*	Observer	No. of exposures	Quality of images	No. of interpolations
1	June 9, 1912	+0 18	B.	3	1	0
2	Feb. 14, 1913	+0 40	M.	3	2	2
3	Mar. 11, 1913	0 54	B.	3	2	0
4	May 8, 1913	+0 0	M.	3	5	2
5	May 19, 1913	−0 12	B.	2	4	2
6	June 12, 1913	+1 0	M.	3	4	4
7	Feb. 1, 1914	+0 25	P.	3	5	1
8	Feb. 7, 1914	−0 3	S.	3	4	1
9	Mar. 3, 1914	0 22	P.	3	5	0
10	Mar. 4, 1914	+0 4	S.	2	4	0
11	May 18, 1914	+0 15	S.	3	3	2
12	May 31, 1914	0 50	M.	3	5	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.7	−4.79	−0.889	−1.266	.010	S.
2	.7	−2.29	+0.774	1.256	.009	S.
3	.9	2.04	.444	1.259	.005	S.
4	.8	−1.46	−0.508	1.250	.011	S.
5	.7	1.35	.661	1.266	.005	S.
6	.8	1.11	.911	1.262	.002	S.
7	.9	+1.23	+0.893	1.260	.008	S.
8	.9	1.29	.845	1.273	.005	S.
9	.9	1.53	.566	1.279	.012	S.
10	.8	1.54	.552	1.277	.010	S.
11	.5	+2.29	−0.645	1.262	.002	S.
12	.9	2.42	.802	1.256	.007	S.

COMPARISON STARS.

No.	*X*	*Y*	Dependence	Diameter	B. D. No.	Magnitude
1	+ 55.569	− 74.098	0.07	0.45		
2	139.937	27.679	0.16	0.40		
3	127.167	+ 42.080	0.33	0.48	+11° 2590	9.2
4	−322.674	59.696	0.44	0.49	+11 2584	9.3
π	75.011	30.302		0.67		

Normal equations:

$$42.220\mu - 1.595c + 3.893\pi = + \ 1.962.$$
$$+9.505 \ \ +0.194 \ = -12.010.$$
$$+5.004 \ = - \ 0.266.$$

Solution:

$$\mu = -0''.005 \pm 0.''004.$$
$$c = -1 \ .264.$$
$$\pi = -0''.016 \pm 0''.012.$$

p. e. unit weight $\pm 0''.026$.

B. D. $+42° \ 2531$. O Σ 285. ($14^h \ 41^m.7$, $+42° \ 49'$.)
Mag. 7.1 − 7.6.

The measures were in right ascension. This is a close binary star with a long period. The components are of about the same magnitude and so close together that the combined image shows no elongation. The image was bisected in making the measures.

Russell determined a hypothetical parallax of 0''.012 for this star.

TABLE 1.

No.	Date	Hour angle	Observer	No. of expo-sures	Quality of images	No. of inter-polations
		hr. min.				
1	Mar. 3, 1914	−0 30	P.	3	4	0
2	Mar. 4, 1914	0 16	S.	3	3	0
3	Mar. 12, 1914	0 36	P.	3	2	1
4	Mar. 24, 1914	0 5	M.	3	5	0
5	Mar. 25, 1915	+0 36	P.	2	4	0
6	Apr. 4, 1915	0 8	P.	2	2	0
7	June 17, 1915	+0 20	M.	2	2	0
8	June 20, 1915	0 20	M.	3	3	0
9	June 28, 1915	0 20	M.	2	3	0
10	June 22, 1916	+0 30	S.	1	2	0
11	June 26, 1916	0 17	P.	1	4	0
12	June 30, 1916	0 20	P.	1	3	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.9	−3.98	+0.82	−0.040	.004	S.
2	.8	3.97	.81	.034	.002	S.
3	.8	3.89	.73	.035	.000	S.
4	1.0	3.77	.59	.035	.001	S.
5	.9	−0.11	+0.58	.059	.000	S.
6	.8	0.01	.45	.059	.000	S.
7	.8	+0.73	−0.66	.052	.005	S.
8	.8	0.76	.69	.050	.007	S.
9	.5	0.84	.77	.073	.017	S.
10	.6	4.44	−0.73	.077	.003	S.
11	.8	4.48	.77	.082	.003	S.
12	.7	4.52	.81	.081	.001	S.

COMPARISON STARS.

No.	X	Y	Depend-ence	Diameter	B. D. No.	Mag-nitude
1	+202.520	+11.649	+0.041	0.57	+42° 2533	9.2
2	126.968	−77.278	0.414	0.37		
3	−129.184	+23.131	0.277	0.38	42 2529	9.5
4	200.305	42.497	0.268	0.47	42 2527	9.5
π	28.638	−13.754		0.42		

Normal equations:

$$9.400c - 2.723\mu + 0.356\pi = -0.514.$$
$$96.622\delta - 18.462 = -0.348.$$
$$4.648 = +0.069.$$

Solution:

$$\mu = -0''.030 \pm 0''.003.$$
$$c = -0 \;.056.$$
$$\pi = -0''.028 \pm 0''.015.$$

p. e. unit weight $\pm 0''.016$.

B. D. $+37^\circ$ 2636. μ Bootis. ($15^h 20^m.7$; $+37^\circ 44'$.)
Mag. 4.47. $\mu = -0^s.0126$; $+0''.078$. Spectrum F.

This star is measured in longitude. No parallax for this star has been published.

TABLE 1.

No.	Date	Hour angle	Observer	No. of expo-sures	Quality of images	No. of inter-polations
		hr. min.				
1	Mar. 17, 1913	+0 30	M.	3	3	0
2	June 30, 1913	−0 36	B.	3	4	0
3	July 4, 1913	0 6	B.	3	3	0
4	Feb. 7, 1914	+0 20	S.	3	2	1
5	Mar. 4, 1914	0 13	S.	2	4	0
6	Mar. 13, 1914	0 25	M.	2	2	0
7	Mar. 20, 1914	−0 10	M.	3	2	0
8	Mar. 24, 1914	0 7	M.	3	4	0
9	Mar. 12, 1915	+0 30	M.	2	2	0
10	Mar. 31, 1915	−0 15	Ma.	3	4	1
11	June 5, 1915	+0 10	Ma.	3	5	0
12	June 9, 1915	−0 25	P.	3	3	0
13	June 28, 1915	+0 30	M.	3	5	0
14	July 1, 1915	0 23	Ma.	3	5	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.5	−4.83	+0.572	+0.047	.006	P.
2	.6	−3.78	−0.937	.029	.011	P.
3	.5	3.74	.961	−0.012	.029	P.
4	.9	−1.56	+0.945	+0.008	.003	P.
5	.9	1.31	.740	.004	.004	P.
6	.5	1.22	.629	.007	.009	P.
7	.9	1.15	.532	−0.008	.006	P.
8	.7	1.11	.472	.000	.004	P.
9	.9	+2.42	+0.646	0.059	.014	P.
10	1.0	2.61	.369	.052	.004	P.
11	.5	+3.27	−0.691	+0.051	.013	P.
12	.9	3.31	.738	.060	.004	P.
13	8	3.50	.921	.069	.002	P.
14	1.0	3.53	.941	.065	.004	P.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
2	+139.266	− 65.035	0.201	0.83	+37° 2639	8.9
3	−176.234	96.530	0.365	0.67		
5	+ 36.969	+161.566	0.434	0.64	38° 2654	9.2
π	− 20.296	21.686		1.20		

Normal equations:

$$10.600c + 4.174\mu + 0.146\pi = -0.262.$$
$$+83.311 \quad -7.821 \quad = -1.121.$$
$$+5.863 \quad = +0.130.$$

Solution:

$$\mu = -0''.055 \pm 0''.003.$$
$$c = -0\ .020.$$
$$\pi = +0''.033 \pm 0''.013.$$

p. e. unit weight $\pm 0''.029$.

B. D. + 37° 2637. μ^2 Bootis = Σ 1938. ($15^h\ 20^m.7$, + 37° 44′.)
Mag. 6.66. $\mu = -0^s.0122; +0''.093$. Spectrum K.

The measures are in longitude. μ^2 Bootis is a binary with a very uncertain period. The combined image of the two components is elongated, but the images are never separated on the plates. In the measurements the attempt was made to bisect this elongated image. The components are so nearly of the same magnitude that the image is fairly symmetrical though long.

Flint found for the parallax of this star the value of + 0″.019. Russell's hypothetical parallax is + 0″.033.

TABLE I.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Mar. 17, 1913	+0 30	M.	3	3	0
2	June 30, 1913	−0 36	B.	3	4	0
3	July 4, 1913	0 6	B.	3	3	0
4	Feb. 7, 1914	+0 20	S.	3	2	1
5	Mar. 4, 1914	0 13	S.	2	4	0
6	Mar. 13, 1914	0 25	M.	2	2	0
7	Mar. 20, 1914	−0 10	M,	3	2	0
8	Mar. 24, 1914	0 7	M.	3	4	0
9	Mar. 12, 1915	+0 30	M.	2	2	0
10	Mar. 31, 1915	−0 15	Ma.	3	4	1
11	June 5, 1915	+0 10	Ma.	3	5	0
12	June 9, 1915	−0 23	P.	3	3	0
13	June 28, 1915	+0 30	M.	3	5	0
14	July 1, 1915	0 23	M.	3	5	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.8	−4.83	+0.572	+0.071	.014	P.
2	.5	−3.78	−0.937	.033	.003	P.
3	.5	3.74	.961	.013	.016	P.
4	.6	−1.56	+0.945	.025	.007	P.
5	1.0	1.31	.740	.033	.005	P.
6	.9	1.22	.629	.018	.007	P.
7	.9	1.15	.532	.026	.003	P.
8	1.0	1.11	.472	.013	.009	P.
9	.7	+2.42	+0.646	−0.013	.005	P.
10	1.0	2.61	.369	.006	.006	P.
11	.5	+3.27	−0.691	.019	.011	P.
12	.8	3.31	.738	.036	.004	P.
13	.8	3.50	.921	.035	.000	P.
14	1.0	3.53	.941	.032	.003	P.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
2	+139.266	− 65.035	0.293	0.83	+37° 2639	8.9
3	−176.234	96.530	0.366	0.67		
5	+ 36.969	+161.566	0.341	0.64	38° 2654	9.2
π	− 11.064	0.721		0.72		

Normal equations:

$$11.000c + 1.804\mu + 0.539\pi = +0.067.$$
$$+87.022 \quad -9.189 \quad = -0.869.$$
$$+5.757 \quad = +0.152.$$

Solution:

$$\mu = -0''.042 \pm 0''.003.$$
$$c = +0\ .007.$$
$$\pi = +0''.054 \pm 0''.011.$$

p. e. unit weight $\pm 0''.024$.

B. D. + 26° 2722. γ Coronæ Borealis = Σ 1967. ($15^h\ 38^m.6$, + 26° 37′.)
Mag. 3.93. $\mu = -\ 0^s.0075$; $+\ 0''.030$. Spectrum A.

The measures are in longitude. This is a binary with a period of 73 years. The combined image of the components was not sensibly elongated and was bisected in measuring.

Russell finds a parallax (hypothetical) of $+0''.025$ for this star.

TABLE 1.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	July 5, 1912	+0 12	B.	3	1	0
2	July 11, 1912	1 15	M.	2	5	0
3	Mar. 2, 1913	+0 0	B.	2	1	0
4	Mar. 11, 1913	0 30	B.	3	3	0
5	Mar. 4, 1914	+0 43	S.	3	2	2
6	Mar. 13, 1914	1 10	M.	3	3	0
7	Mar. 20, 1914	0 0	M.	3	5	0
8	Mar. 24, 1914	0 50	M.	3	5	0
9	Apr. 5, 1914	0 50	P.	3	5	1
10	June 28, 1915	+0 45	M.	2	4	0
11	July 6, 1915	0 30	M.	3	5	0
12	July 8, 1915	1 10	Ma.	3	5	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.7	−5.74	−0.880	−0.837	.004	S.
2	.7	5.68	.926	.842	.002	S.
3	.7	−3.34	+ .871	.813	.004	S.
4	.8	3.25	.788	.810	.001	S.
5	.8	+0.33	+.856	.775	.003	S.
6	.8	.42	.769	.771	.008	S.
7	.9	.49	.689	.774	.004	S.
8	1.0	.53	.638	.782	.003	S.
9	.9	.65	.470	.784	.005	S.
10	.6	+5.14	−0.806	.749	.000	S.
11	.8	5.22	.881	.747	.003	S.
12	.8	5.24	.898	.753	.003	S.

COMPARISON STARS.

No.	*X*	*Y*	Dependence	Diameter	B. D. No.	Magnitude
2	− 40.819	+ 2.047	0.20	0.38		
4	+118.117	148.604	0.22	0.66		
5	164.084	−169.952	0.21	0.68		
6	−136.999	+208.004	0.19	0.28	+2.6° 2720	8.9
7	104.384	−188.703	0.18	0.37	2.6 2721	9.1
π	+ 6.649	+ 2.926		0.39		

Normal equations:

$$9.500c + 0.675\mu + 1.052\pi = -7.466.$$
$$+122.631 \quad -5.396 \quad = +0.451.$$
$$+5.918 \quad = -0.834.$$

Solution: $\mu = +0''.039 \pm 0''.001.$

$c = -0\ .787.$

$\pi = +0''.031 \pm 0''.006.$

p. e. unit weight $\pm 0''.013$.

B. D. + 31° 2884. ζ Herculis = Σ 2084. ($16^h\ 37^m.5$, + 31° 47′.)
Mag. 3.00. $\mu = -0^s.0365$; $+0''.385$. Spectrum G.

The measures are in longitude. This is a binary with a period of 34.53 years. The combined image of the two components is slightly elongated. It was bisected in measuring. Parallaxes by Russell, Flint, and Smith are as follows:

Russell (Photography)	+0″.101
Flint (Transits)	0″.138
Smith (Heliometer)	0″.17
Russell (Hypothetical)	0″.102

TABLE 1.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Mar. 29, 1912	+0 42	B.	3	1	0
2	Mar. 31, 1912	0 42	B.	1	3	0
3	Apr. 24, 1912	0 6	B.	3	5	0
4	Apr. 30, 1912	0 12	B.	3	5	0
5	May 4, 1912	0 6	Mt.	3	5–1	0
6	July 11, 1912	+0 15	M.	3	3	1
7	July 27, 1912	0 24	B.	2	3	0
8	Mar. 17, 1913	+0 0	M.	2	3	0
9	Mar. 18, 1913	0 0	B.	3	1	0
10	Apr. 25, 1913	0 40	M.	3	3	0
11	June 28, 1913	+0 0	S.	3	5	2
12	July 4, 1913	−0 18	B.	3	2	2
13	July 11, 1913	0 36	B.	3	3	1
14	July 14, 1913	+0 6	B.	3	2	1
15	July 16, 1913	−0 30	B.	3	2	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.4	−2.78	+0.776	+0.922	.004	M.
2	.5	2.76	.754	.926	.000	S.
3	.9	2.52	.434	.911	.001	S.
4	.5	2.46	.340	.904	.002	M.
5	.7	2.42	.276	.900	.004	S.
6	.6	−1.74	−0.768	.866	.007	S.
7	.6	1.58	.915	.854	.005	S.
8	.7	+0.75	+0.880	.787	.006	S.
9	.9	.76	.872	.807	.014	S.
10	.7	1.14	.432	.768	.002	S.
11	.6	+1.78	−0.604	.727	.000	S.
12	.8	1.84	.682	.723	.000	S.
13	.6	1.91	.765	.711	.008	S.
14	.9	1.94	.798	.719	.002	S.
15	1.0	1.96	.818	.719	.003	M.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
1	+119.236	+103.705	0.29	0.48	+31° 2887	9.2
3	−218.970	75.691	0.24	0.26		
4	156.748	−114.182	0.20	0.54	32 2764	9.0
8	+256.483	65.216	0.27	0.78	31 2892	8.4
π	20.664	+ 8.353		0.61		

Normal equations:

$$38.915\mu - 0.275c - 6.218\pi = -1.824.$$
$$+10.408 \quad -0.767 \quad = +8.390.$$
$$+5.207 \quad = -0.285.$$

Solution:

$$\mu = -0''.179 \pm 0.''003.$$
$$c = +0\ .806.$$
$$\pi = +0''.086 \pm 0''.008.$$

p. e. unit weight $\pm 0.''015$.

B. D. + 28° 2624. Σ 2107. ($16^h 48^m$, +28° 50′.)
Mag. 8.0 − 8.5.

The measures were in longitude. This star is a binary with a period yet to be determined.

Russell finds a hypothetical parallax of + 0″.022 for this star.

Table I.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Mar. 3, 1914	−0 23	P.	3	4	1
2	Apr. 5, 1914	+0 28	P.	3	5	1
3	Apr. 10, 1914	0 30	P.	3	5	0
4	Apr. 13, 1914	0 50	M.	2	5	1
5	Apr. 17, 1914	−0 3	P.	2	5	0
6	July 19, 1914	+1 20	M.	2	2	0
7	July 28, 1914	1 0	M.	3	5	0
8	July 29, 1914	0 52	M.	2	5	0
9	July 30, 1914	1 25	M.	2	5	0
10	July 31, 1914	0 50	M.	3	5	0
11	Aug. 6, 1914	1 15	M.	2	5	0
12	Aug. 9, 1914	1 35	M.	3	5−2	1
13	Mar. 31, 1915	+0 30	Ma.	3	3	0
14	Apr. 4, 1915	−0 34	P.	3	5	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.9	−1.14	+0.982	+0.054	.005	M.
2	.9	0.81	.757	.045	.004	M.
3	.9	.76	.699	.045	.004	M.
4	.8	.73	.662	.047	.002	M.
5	.8	.69	.610	.046	.002	M.
6	.9	+0.24	−0.797	.051	.005	M.
7	.6	.33	.882	.054	.008	M.
8	.8	.34	.890	.047	.001	M.
9	.7	.35	.898	.051	.005	M.
10	.7	.36	.905	.041	.005	M.
11	.8	.42	.946	.037	.009	M.
12	.7	.45	.963	.038	.008	M.
13	.9	+2.79	+0.811	.042	.004	M.
14	.9	2.83	.771	.050	.004	M.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
1	+ 80.263	+127.711	0.478	0.62	+28° 2626	9.0
2	− 54.985	91.911	0.093	0.69	28 2622	8.8
3	49.080	9.361	0.111	0.30		
5	+ 23.803	−228.982	0.318	0.41		
π	35.423	2.164		0.55		

Normal equations:

$$11.300c + 3.317\mu - 0.016\pi = 0.527.$$
$$+17.970 \quad -0.418 \quad = 0.142.$$
$$+7.774 \quad = 0.009.$$

Solution:

$$\mu = -0''.003 \pm 0''.004.$$
$$c = +0\ .047.$$
$$\pi = +0''.006 \pm 0''.006.$$

p. e. unit weight $\pm 0''.017$.

B. D. + 33° 2864. u Herculis. ($17^h\ 13^m.6$, + 33° 12′.)
Mag. var. $\mu = -0^s.0016; -0''.013$. Spectrum B_3.

The measures are in longitude. This is a spectroscopic binary. No other parallax of this star has been published.

TABLE 1.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Apr. 23, 1914	+0 0	P.	3	5	0
2	Apr. 30, 1914	−0 24	P.	3	5	0
3	May 2, 1914	+0 0	S.	3	3	0
4	May 18, 1914	0 55	M.	2	4	0
5	July 28, 1914	+1 38	M.	3	4	0
6	July 29, 1914	1 17	M.	3	4	0
7	Aug. 15, 1914	0 30	P.	3	5	0
8	Aug. 17, 1914	0 25	P.	3	2	0
9	Aug. 19, 1914	0 25	P.	3	2	0
10	Apr. 4, 1915	−0 33	P.	3	4	0
11	Apr. 14, 1915	0 20	Ma.	3	4	0
12	Apr. 15, 1915	0 28	P.	3	4	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	1.0	−1.37	+0.636	−0.139	.005	P.
2	1.0	1.30	.541	.131	.000	P.
3	1.0	1.28	.512	.130	.003	P.
4	.8	1.12	.255	.133	.001	P.
5	.8	−0.41	−0.803	.135	.001	P.
6	.8	0.40	.813	.119	.005	P.
7	1.0	0.23	.949	.125	.003	P.
8	1.0	0.21	.962	.120	.002	P.
9	1.0	0.19	.969	.116	.006	P.
10	.8	+2.09	+0.850	.134	.004	P.
11	1.0	2.19	.751	.125	.004	P.
12	.8	2.20	.739	.130	.001	P.

COMPARISON STARS.

No.	*X*	*Y*	Dependence	Diameter	B. D. No.	Magnitude
1	−147.638	−155.877	0.129	0.63	+32° 2877	8.3
2	143.925	48.464	0.170	0.39	33 2860	9.3
3	96.408	+ 24.969	0.202	0.43		
8	+116.218	289.822	0.320	0.61	33 2868	9.0
9	271.755	−110.448	0.179	1.03	33 2871	7.8
π	22.713	+ 49.872		0.39		

Normal equations:

$$11.000c - 0.502\mu - 0.257\pi = -1.406.$$
$$+18.766 \quad +3.036 \quad = +0.076.$$
$$+6.399 \quad = -0.004.$$

Solution:

$$\mu = +0''.008 \pm 0''.004.$$
$$c = -0\ .128.$$
$$\pi = -0''.031 \pm 0''.007.$$

p. e. unit weight $\pm 0''.016$.

B.D. + 61° 1678. 26 Draconis = β 962. ($17^h\,34^m$. + 61° 58′.)
Mag. 5.31. μ = + $0^s.035$; − $0''.50$. Spectrum F.

The measures are in longitude. This is a binary star. The components form a combined image, which is sensibly circular, and which was bisected in the measuring. Chase found the parallax of this star to be + $0''.08$. The hypothetical parallax computed by Adams and by Russell is, respectively, + $0''.09$ and + $0''.040$.

TABLE 1.

No.	Date	Hour angle	Observer	No. of expo-sures	Quality of images	No. of inter-polations
		hr. min.				
1	Mar. 11, 1913	−0 42	B.	2	5	0
2	May 1, 1913	+0 24	B.	3	2	0
3	July 11, 1913	−0 36	B.	2	2	0
4	July 16, 1913	0 30	B.	3	5	0
5	July 18, 1913	0 12	B.	3	4	0
6	July 21, 1913	0 12	B.	3	4	0
7	Mar. 20, 1914	−0 6	M.	1	3	0
8	Apr. 3, 1914	0 15	M.	3	2	0
9	Apr. 18, 1914	+0 15	M.	3	2	0
10	Apr. 22, 1914	−0 10	S.	3	1	0
11	Apr. 30, 1914	+0 15	P.	3	5	0
12	Apr. 7, 1915	−0 15	Ma.	2	2	0
13	Apr. 14, 1915	+0 20	Ma.	2	4	0
14	Apr. 15, 1915	0 5	P.	2	5	1
15	Apr. 21, 1915	0 25	Ma.	2	3	0
16	May 9, 1915	−0 3	P.	2	5	0
17	July 16, 1915	+0 20	M.	3	5	0
18	July 18, 1915	0 2	M,	3	4	0
19	July 23, 1915	0 11	M.	3	5	0
20	July 24, 1915	−0 35	Ma.	3	5	0
21	Apr. 30, 1916	−0 7	P.	3	5	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.6	−5.23	+0.896	+0.039	.001	P.
2	1.0	4.72	.250	.060	.024	P.
3	.6	−4.01	−0.816	.048	.021	P.
4	.9	3.96	.864	.008	.019	P.
5	.5	3.94	.882	.015	.012	P.
6	.5	3.91	.906	.020	.007	P.
7	.5	−1.49	+0.822	.087	.001	P.
8	.5	1.35	.666	.064	.023	P.
9	.8	1.20	.458	.068	.018	P.
10	.5	1.16	.395	.082	.003	P.
11	.5	1.08	.269	.073	.011	P.
12	.6	+2.34	+0.616	.135	.001	P.
13	1.0	2.41	.521	.156	.023	P.
14	.6	2.42	.507	.128	.005	P.
15	.5	2.48	.414	.142	.010	P.
16	.5	2.66	.124	.121	.008	P.
17	.9	+3.34	−0.860	.138	.017	P.
18	.5	3.36	.878	.118	.003	P.
19	.7	3.41	.917	.119	.002	P.
20	.5	3.42	.924	.124	.003	P.
21	.8	+6.23	+0.257	.161	.016	P.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
2	−171.004	+ 83.260	+0.829	+0.55	+56° 1672	9.4
3	85.070	29.056	.390	.84	56° 1675	8.5
4	92.256	− 94.079	−0.845	.54	56° 1673	9.3
7	+166.157	7.170	+0.323	.62	56° 1680	9.4
8	182.172	11.067	.303	.55	56° 1681	9.3
π	11.941	+154.109		.62		

Normal equations:

$$13.500c + 0.350\mu - 0.578\pi = 1.248.$$
$$+162.230 \quad -0.330 \quad = 2.121.$$
$$+6.124 \quad = 0.047.$$

Solution:

$$\mu = +0''.061 \pm 0''.003.$$
$$c = +0\ .093.$$
$$\pi = +0''.080 \pm 0''.016.$$

p. e. unit weight $\pm 0''.041$.

B. D. +2° 3482. 70 Ophiuchi. ($18^h\ 0^m.4$, + 2° 31′.)
Mag. 4.07. $\mu = +0^s.0169$; $-1''.102$. Spectrum K.

The measures are in longitude. This is a binary with a period of 86.66 years. Only the brighter component was measured.

The following parallaxes have been published:

Schor (Heliometer) .... $+0''.286$
Krueger (Heliometer) .... $+0''.150$
Flint (Transits) .... $+0''.19$
Slocum (Photography) .... $+0''.212$
Mitchell (Photography) .... $+0''.165$
Adams (Hypothetical) .... $+0''.22$

TABLE I.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Apr. 17, 1914	+0 0	P.	1	2	0
2	Apr. 30, 1914	0 43	P.	3	2	0
3	May 2, 1914	0 2	S.	3	3	0
4	May 9, 1914	0 25	S.	2	1	0
5	Aug. 17, 1914	+0 53	P.	3	2	0
6	Aug. 23, 1914	0 8	P.	3	4	1
7	Aug. 30, 1914	0 34	P.	3	5	0
8	Aug. 31, 1914	1 6	P.	3	5	0
9	May 9, 1915	+0 17	P.	3	4	0
10	July 23, 1915	+0 40	M.	3	5	0
11	Aug. 13, 1915	0 45	P.	3	4	0
12	Aug. 16, 1915	0 43	P.	3	4	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.6	−2.02	+0.892	+0.126	.003	P.
2	.7	1.86	.772	.131	.004	P.
3	1.0	1.84	.750	.128	.002	P.
4	.9	1.77	.666	.127	.004	P.
5	.5	0.77	−0.818	.070	.003	P.
6	1.0	0.71	.872	.072	.000	P.
7	.7	0.64	.925	.074	.004	P.
8	.8	0.63	.931	.069	.010	P.
9	.8	+1.88	+0.668	.141	.011	P.
10	.5	+2.63	−0.503	.124	.012	P.
11	1.0	2.84	.775	.106	.003	P.
12	1.0	2.87	.806	.103	.001	P.

COMPARISON STARS.

No.	*X*	*Y*	Dependence	Diameter	B. D. No.	Magnitude
4	+128.692	+ 32.881	0.033	0.53	+ 2° 3487	9.5
7	71.384	−141.125	0.591	0.47	2 3483	9.3
9	−200.076	+108.243	0.376	0.47	2 3479	9.5
π	28.662	− 41.685		0.58	π	

Normal equations:

$$
\begin{aligned}
9.500c + 0.535\mu - 1.549\pi &= 1.001. \\
+35.070 \quad -6.880 &= 0.065. \\
+5.979 &= 0.005.
\end{aligned}
$$

Solution:

$$
\begin{aligned}
\mu &= +0''.036 \pm 0''.004. \\
c &= +0\ .111. \\
\pi &= +0''.181 \pm 0''.009.
\end{aligned}
$$

p. e. unit weight $\pm 0''.019$.

B. D. + 32° 3267. Bradley 2388 = β648 ($18^h 53^m.3$, + 32°47′.)
Mag. 5.21. $\mu = + 0^s.0137; - 0''.160$. Spectrum G.

The measures were made in longitude. This is a binary with a period of 45.85 years. The combined image of the two components is very slightly elongated. In the measurements we attempted to bisect this elongated image.

Other parallaxes of this star published are:

Flint (Transits) .... $+0''.01$
Russell (Hypothetical) .... $+0''.071$

TABLE 1.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	May 11, 1913	−0 6	B.	3	5	0
2	May 14, 1913	+0 30	M.	2	4	0
3	May 18, 1913	0 18	B.	3	4	0
4	June 2, 1913	0 36	S.	3	5	0
5	May 2, 1914	−0 7	S.	3	5	1
6	May 20, 1914	+0 36	S.	3	4	0
7	Aug. 15, 1914	+0 25	P.	2	4	0
8	Aug. 23, 1914	0 4	P.	3	5	2
9	Aug. 30, 1914	0 12	P.	3	5	0
10	Sept. 2, 1914	−0 20	P.	3	5	0
11	Sept. 4, 1914	+0 6	P.	3	5	4
12	Sept. 5, 1914	−0 29	P.	3	5	1

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.5	−3.01	+0.867	−0.093	.010	M.
2	.7	2.98	.840	.073	.010	S.
3	.9	2.94	.801	.084	.000	S.
4	.5	2.79	.624	.089	.002	M.
5	.7	+0.55	+0.935	.046	.001	S.
6	.5	0.73	.783	.046	.003	M.
7	.6	+1.60	−0.541	.085	.009	M.
8	.5	1.68	.649	.071	.008	S.
9	.7	1.75	.735	.073	.007	M.
10	.7	1.78	.768	.087	.006	M.
11	.6	1.80	.789	.089	.009	M.
12	.7	1.81	.799	.070	.011	M.

COMPARISON STARS.

No.	*X*	*Y*	Dependence	Diameter	B. D. No.	Magnitude
2	+ 31.982	−145.131	0.323	0.42		
5	−155.459	162.803	0.199	0.86	+18° 3276	8.7
6	126.512	55.970	0.146	0.91	18° 3275	8.5
11	+102.375	+170.457	0.157	0.67	18° 3263	9.0
12	147.612	193.446	0.175	0.57	19° 3263	9.1
π	2.884	− 26.725		0.64		

Normal equations:

$$7.600c - 0.264\mu + 0.367\pi = -0.575.$$
$$+34.441 \quad -10.190 \quad = +0.083.$$
$$+ 4.561 \quad = -0.005.$$

Solution:

$$\mu = +0''.046 \pm 0''.006.$$
$$c = -0\ .077.$$
$$\pi = +0''.126 \pm 0''.017.$$

p. e. unit weight $\pm 0''.021$.

B. D. $+44°$ 3234. δ Cygni. ($19^h 41^m.9$, $+44° 53'$.)
Mag. 2.97. $\mu = +0^s.0050$; $+0''.037$. Spectrum A.

The measures are in longitude. This is a binary of very long period. In order to choose the comparison stars we adopted the method described on pages 10 to 16 of this paper. The preliminary measures indicated that a field consisting of stars numbered 2, 6, 7, and 10 should give a larger parallax than any other symmetrically arranged field on the plate, and that a field consisting of stars numbered 1, 3, 6, and 9 should give a smaller parallax than any other symmetrically arranged field. In order to test the method prescribed in Part II of this paper we decided to measure both fields, and, in order that the final parallax should not be prejudiced by errors made in the measures for the determination of the field, we rejected, for the purpose of determining the parallax, all but three of the plates used in choosing the field and measured seven additional plates.

The data and reductions for the first field (stars 2, 6, 7, and 10) are given in Tables 1 and 2, and following these are the normal equations and solution. The same items are given for the field 1, 3, 6, and 9 in Tables 3 and 4. The normal equations and solution for this field follow the tables. One plate in the first series is not in the second and three in the second series are not in the first. This seemed desirable because of the quality of the images of some of the comparison stars. The results for the first field are $\pi = +0''.049 \pm 0''.008$ and for the second $\pi = 0''.007 \pm 0''.019$, which indicate that the method really tells us something as to the relative distance of comparison stars. A hypothetical parallax of this star computed by Russell is $0''.031$.

TABLE 1.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Aug. 30, 1914	+0 0	P.	3	5	0
2	Sept. 9, 1914	−0 56	P.	3	2	1
3	May 19, 1915	+0 20	Ma.	2	2	0
4	June 9, 1915	0 0	Ma.	3	4	2
5	June 14, 1915	0 0	Ma.	3	5	0
6	June 17, 1915	0 20	M.	3	5	0
7	Sept. 7, 1915	+0 23	P.	2	4	0
8	Sept. 10, 1915	0 8	S.	3	5	1
9	Sept. 24, 1915	0 6	P.	2	5	0
10	Sept. 29, 1915	0 15	P.	3	3	1

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.7	−2.67	−0.373	−0.049	.004	M.
2	.8	.257	.523	.042	.004	M.
3	.7	−.005	+0.985	.043	.006	M.
4	.7	+0.16	.847	.037	.001	M.
4	.7	0.21	.799	.038	.001	M.
6	.6	0.24	.766	.034	.006	M.
7	.8	+1.06	−0.492	.044	.010	M.
8	.7	1.09	.535	.058	.002	M.
9	.8	1.23	.718	.062	.005	M.
10	.8	1.28	.775	.060	.002	M.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
2	−231.911	− 75.842	0.396	0.47		
6	+184.995	+ 66.903	0.133	0.48	+44° 3246	9.5
7	− 67.107	196.163	0.276	0.50		
10	+114.024	−187.223	0.195	0.54	44° 3245	9.5
π	− 63.568	3.437		0.76		

Normal equations:

$$7.300c + 0.062\mu - 0.340\pi = -0.345.$$
$$+14.611 \quad -0.267 \quad = -0.040.$$
$$+3.584 \quad = +0.054.$$

Solution:

$$\mu = -0''.011 \pm 0''.004.$$
$$c = -0\ .047.$$
$$\pi = +0''.049 \pm 0''.008.$$

p. e. unit weight $\pm 0''.016$.

TABLE 3.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	May 30, 1914	+0 5	S.	2	2	1
2	June 6, 1914	0 10	S.	3	2	2
3	Sept. 5, 1914	+0 2	P.	2	5	1
4	Sept. 9, 1914	−0 56	P.	3	2	2
5	May 19, 1915	+0 30	Ma.	2	2	2
6	June 9, 1915	0 0	Ma.	3	4	0
7	June 14, 1915	0 0	Ma.	3	5	0
8	June 17, 1915	0 20	M.	3	5	0
9	Sept. 10, 1915	+0 8	S.	3	5	0
10	Sept. 22, 1915	0 20	P.	2	2	0
11	Sept. 24, 1915	0 6	P.	3	5	0
12	Sept. 29, 1915	0 15	P.	3	3	0

TABLE 4.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.5	−3.01	+0.925	−0.192	.015	M.
2	.9	2.94	.872	.186	.009	M.
3	.9	−2.03	−0.466	.153	.023	M.
4	.8	1.99	.523	.180	.005	M.
5	.7	+0.53	+0.985	.142	.023	M.
6	.8	.74	.847	.164	.001	M.
7	.8	.79	.799	.164	.000	M.
8	.8	.82	.766	.166	.002	M.
9	.8	+1.67	−0.535	.176	.012	M.
10	.7	1.79	.694	.154	.009	M.
11	.8	1.81	.718	.160	.003	M.
12	.6	1.86	.775	.184	.021	M.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
1	−194.470	+180.158	+0.283	0.53	+44° 3222	9.1
3	151.030	−106.019	.218	0.51	44° 3227	9.5
6	+251.930	+ 88.088	.283	0.48	44° 3246	9.5
9	93.570	−162.226	.216	0.79	44° 3238	8.9
π	3.367	+ 17.748		0.76		

Normal equations:

$$9.100c - 0.166\mu + 1.078\pi = -1.526.$$
$$30.039 \quad -3.642 \quad = +0.120.$$
$$5.100 \quad = -0.185.$$

Solution:

$$\mu = +0''.015 \pm 0''.008.$$
$$c = -0\ .168.$$
$$\pi = +0''.007 \pm 0''.019.$$

p. e. unit weight $\pm 0''.041$.

B. D. $+44°$ 3242. ($19^h 42^m.8$, $+44°$ 51.′8.)
Mag. 9.2.

The measures are in longitude. This star was on the plates with δ Cygni. When the comparison stars for δ Cygni were being selected by the method described in pages 10 to 16, it seemed that this star should give a sensible positive parallax, and it was measured and reduced for that reason, which seems to indicate that absolute reliance cannot be placed in the relative parallaxes of comparison stars, determined as described in this paper. No other parallax of this star has been published.

TABLE I.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	May 30, 1914	+0 5	S.	3	2	1
2	June 6, 1914	0 10	S.	3	2	1
3	Sept. 5, 1914	+0 2	P.	2	5	1
4	Sept. 9, 1914	−0 56	P.	3	2	1
5	May 19, 1915	+0 20	Ma.	2	2	1
6	June 9, 1915	0 0	Ma.	3	4	0
7	June 14, 1915	0 0	Ma.	3	5	0
8	June 17, 1915	0 20	M.	3	5	0
9	Sept. 10, 1915	+0 8	S.	3	5	0
10	Sept. 22, 1915	0 20	P.	2	2	0
11	Sept. 24, 1915	0 6	P.	3	5	0
12	Sept. 29. 1915	0 15	P.	3	3	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.7	−3.01	+0.925	+0.030	.004	M.
2	.7	2.94	.872	.040	.006	M.
3	.6	−2.03	−0.466	.041	.000	M.
4	.7	1.99	.523	.038	.003	M.
5	.8	+0.53	+0.985	.054	.006	M.
6	.8	0.74	.847	.043	.006	M.
7	.9	0.79	.799	.044	.005	M.
8	.8	0.82	.766	.052	.003	M.
9	.8	+1.67	−0.535	.051	.005	M.
10	.7	1.79	.694	.054	.003	S.
11	.8	1.81	.718	.060	.003	M.
12	.8	1.86	.775	.063	.006	M.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude.
5	− 80.254	− 32.019	0.307	1.14	+44° 3236	8.0
6	+103.195	+178.820	0.338	0.48	44° 3246	9.5
9	− 55.165	− 71.494	0.231	0.79	44° 3238	8.9
10	+ 32.224	75.306	0.124	0.54	44° 3245	9.5
π	1.538	+ 24.763		0.70		

Normal equations:

$$9.100c + 1.132 + 1.302\pi = 0.436.$$
$$+29.262 - 4.235 = 0.182.$$
$$+5.306 = 0.032.$$

Solution:

$$\mu = +0''.019 \pm 0''.003.$$
$$c = +0\ .478.$$
$$\pi = -0''.012 \pm 0''.007.$$

p. e. unit weight $\pm 0''.014$.

B. D. + 14° 4369. β Delphini. ($20^h 32^m.9$, + 14° 15′.)
Mag. 372. $\mu = +0^s.0074$; − 0″.037. Spectrum F_5.

The measures are in longitude. This is a binary with a period of 26.79 years. The combined image of the components did not show any sensible elongation.

Flint found for the parallax of this star a value of − 0″.02. Russell's hypothetical parallax of this star is + 0″.038.

Table 1.

No.	Date	Hour angle	Observer	No. of expo-sures	Quality of images	No. of inter-polations
		hr. min.				
1	June 2, 1913	+0 0	S.	3	4	1
2	Sept. 24, 1913	−0 10	S.	3	4	0
3	Sept. 28, 1913	0 28	M.	3	3	0
4	Aug. 30, 1914	+0 5	P.	3	5	0
5	Sept. 2, 1914	0 0	P.	3	3	1
6	Sept. 5, 1914	0 8	P.	2	4	0
7	Sept. 16, 1914	0 3	M.	3	3	1
8	Sept. 26, 1914	−0 30	P.	3	4	1
9	June 9, 1915	+0 20	Ma.	2	4	0
10	June 17, 1915	0 35	M.	3	5	0
11	June 20, 1915	0 40	M.	2	4	0
12	June 23, 1915	1 5	Ma.	3	4	0

Table 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.9	−4.61	+0.902	+0.070	.001	P.
2	.6	−3.47	−0.724	.065	.006	P.
3	.8	3.43	.769	.071	.001	P.
4	.9	−0.07	−0.374	.084	.008	P.
5	.8	0.04	.420	.096	.004	P.
6	.9	0.01	.466	.097	.006	P.
7	1.0	+0.10	.622	.094	.002	P.
8	.7	0.20	.745	.083	.009	P.
9	.7	+2.76	+0.847	.100	.012	P.
10	.9	2.84	.766	.119	.006	P.
11	.9	2.87	.732	.105	.007	P.
12	.8	2.90	.696	.121	.009	P.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
3	+143.693	+156.310	−0.213	0.35		
5	−170.681	− 47.056	+0.040	0.64	+14° 4361	9.1
6	137.768	90.455	.283	0.62	14° 4366	9.4
10	+140.609	+ 13.912	.374	0.50		
11	209.178	74.790	.251	0.50		
21	−185.032	−107.504	.265	0.49		
π	20.245	65.178		0.82		

Normal equations:

$$9.900c + 0.552\mu + 0.025\pi = 0.920.$$
$$+62.535 \quad +6.850 \quad = 0.441.$$
$$+4.657 \quad = 0.058.$$

Solution:

$$\mu = +0''.028 \pm 0''.003.$$
$$c = +0\ .093.$$
$$\pi = +0''.016 \pm 0''.011.$$

p. e. unit weight $\pm 0''.022$.

B. D. + 35° 4234. X Cygni. ($20^h\ 39^m.5$, + 35° 14′.)
Mag. var. Spectrum F_{5p}.

The measures are in longitude. This is a spectroscopic binary. No other parallax of this star has been published.

TABLE I.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Sept. 8, 1914	−0 4	P.	3	2	1
2	Sept. 9, 1914	0 25	P.	3	2	1
3	Sept. 10, 1914	0 34	P.	2	5	1
4	June 22, 1915	+0 12	M.	3	5	0
5	June 24, 1915	0 25	M.	3	5	1
6	June 27, 1915	0 25	M.	1	5	0
7	June 28, 1915	0 23	Ma.	2	5	0
8	July 5, 1915	0 10	Ma.	3	5	0
9	July 6, 1915	0 15	M.	2	3	0
10	Sept. 7, 1915	+0 32	P.	3	5	1
11	Oct. 9, 1915	0 15	Ma.	3	2	2
12	Oct. 10, 1915	0 30	S.	3	3	0
13	Oct. 17, 1915	0 25	S.	3	5	0
14	Oct. 24, 1915	0 50	M.	2	3	0
15	Oct. 28, 1915	0 30	M.	3	5	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	1.0	−2.77	−0.322	+0.084	.008	P.
2	.6	2.76	.339	.089	.003	P.
3	1.0	2.75	.354	.101	.009	P.
4	1.0	+0.10	+0.842	.101	.007	P.
5	1.0	0.12	.823	.088	.006	P.
6	.5	0.15	.791	.091	.003	P.
7	1.0	0.16	.780	.090	.004	P.
8	.9	0.23	.699	.097	.003	P.
9	.7	0.24	.686	.099	.005	P.
10	.8	+0.87	−0.301	.095	.000	P.
11	.9	1.19	.752	.083	.012	P.
12	1.0	1.20	.763	.089	.006	P.
13	1.0	1.27	.833	.099	.004	P.
14	.5	1.34	.892	.102	.007	P.
15	.9	1.38	.919	.100	.005	P.

COMPARISON STARS.

No.	*X*	*Y*	Dependence	Diameter	B. D. No.	Magnitude
1	−124.075	+151.387	0.062	0.58		9.0
4	87.294	56.655	0.166	0.40	+35° 4228	9.4
7	115.753	− 79.641	0.354	0.50	34° 4129	9.5
13	+106.532	116.179	0.301	0.66	35° 4240	8.7
15	220.592	12.221	0.117	0.44	35° 4244	9.5
π	− 5.185	45.815		0.38		

Normal equations:

$$12.800c - 0.197\mu - 0.716\pi = +1.199.$$
$$+27.501 \quad -1.676 \quad = +0.002.$$
$$+6.390 \quad = -0.068.$$

Solution:

$$\mu = +0''.004 \pm 0''.004.$$
$$c = +0\ .094.$$
$$\pi = +0''.000 \pm 0''.008.$$

p. e. unit weight $\pm 0''.021$.

B. D. + 38° 4343. 61 Cygni. ($21^h\ 2^m.4$, + 38° 15′.)
Mag. 5.57. $\mu = +0^s.3523;\ +3''.242$. Spectrum K_5.

This is the parallax of the brighter component. It was measured in longitude.

The parallax of the fainter component of this star was obtained at the same time, from the same set of comparison stars. One of the plates was rejected because the image of this component was too faint to measure. The results for the *fainter component* were:

$$\mu = +1''.313 \pm 0''.008.$$
$$\pi = +0''.299 \pm 0''.021.$$

p. e. unit weight = $\pm$ 0″.047.

The star 61 Cygni was chosen because its parallax had been determined many times. We hoped in this way to calibrate our results.

The absolute parallax given by Kapteyn and Weersma for this star is + 0″.311. The hypothetical parallax computed by Russell for this star is + 0″.336. Adams found for the larger component of this star a hypothetical parallax of + 0″.30, and for the smaller component a hypothetical parallax of + 0″.34.

TABLE 1.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	June 8, 1912	−1 12	B.	3	3	0
2	June 10, 1912	1 18	B.	2	1	0
3	June 21, 1912	+0 0	M.	2	1	0
4	June 22, 1912	−0 48	B.	3	2	2
5	July 5, 1912	+0 18	M.	2	2	0
6	Oct. 3, 1912	−0 20	M.	3	2	0
7	Oct. 6, 1912	0 30	M.	3	3	0
8	Oct. 10, 1912	0 10	M.	3	3	1
9	Oct. 11, 1912	+0 0	M.	2	3	0
10	June 11, 1913	+0 0	M.	2	5	0
11	June 13, 1913	0 0	M.	2	3	0
12	June 29, 1913	0 12	B.	2	1	0
13	Sept. 27, 1913	−0 5	M.	3	5	0
14	Sept. 28, 1913	0 22	M.	3	5	0
15	Oct. 16, 1913	0 15	M.	3	2	0
16	Oct. 23. 1913	0 20	M.	2	5	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.9	−2.06	+0.991	−2.146	.002	S.
2	.6	2.04	.984	2.123	.016	M.
3	.3	1.93	.922	2.118	.006	M.
4	.7	1.92	.915	2.115	.005	S.
5	.7	1.79	.798	2.072	.009	M.
6	.5	−0.89	−0.572	1.918	.002	M.
7	.9	0.86	.612	1.920	.010	S.
8	.8	0.82	.665	1.899	.003	M.
9	.5	0.81	.677	1.905	.004	S.
10	.8	+1.62	+0.980	1.110	.001	S.
11	.6	1.64	.971	1.122	.016	M.
12	.6	1.80	.859	1.066	.002	M.
13	.9	+2.70	−0.482	0.906	.005	S.
14	.7	2.71	.497	0.893	.007	M.
15	.5	2.89	.734	0.869	.005	M.
16	.7	2.96	.808	0.838	.011	M.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
4	+146.74	+46.77	0.25	0.33	+38° 4351	9.5
5	−218.18	38.30	0.23	0.24		
6	+207.85	−83.57	0.13	0.34		
16	−229.25	53.94	0.14	0.32		
19	+ 92.84	+52.43	0.25	0.33		
π	2.55	15.59		0.36		

Normal equations:

$$41.874\mu + 2.670c - 6.067\pi = +7.028.$$
$$+10.708 \quad +1.420 \quad = -16.597.$$
$$+6.724 \quad = -3.585.$$

Solution:

$$\mu = +1''.318 \pm 0''.004.$$
$$c = -1\ .629.$$
$$\pi = +0''.301 \pm 0''.009.$$

p. e. unit weight $\pm 0''.022$.

B. D. + 37° 4240. τ Cygni. ($21^h\ 10^m.8$, + 37° 37′.)
Mag 3.82 − 8.00. μ + $0^s.0133$; + 0″ .427. Spectrum F.

The measures were in longitude. This is a binary with a period of 47 years. Other published parallaxes are:

By Jost, who found it to be + 0″.12.
By Millosevich, who found it to be + 0″.029.
By Slocum and Mitchell, who obtained + 0″.006.
By Russell, who obtained a hypothetical parallax of + 0″.046.

TABLE I.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	June 1, 1912	−0 30	M.	2	3	0
2	July 8, 1912	+0 6	B.	3	5	0
3	July 12, 1912	0 12	B.	2	1	0
4	June 30, 1913	−0 12	S.	3	5	0
5	July 3, 1913	+0 0	B.	3	1	0
6	July 7, 1913	1 20	S.	2	2	0
7	July 8, 1913	−1 25	B.	2	1	0
8	Sept. 28, 1913	−0 2	M.	3	3	0
9	Oct. 5, 1913	0 5	M.	3	5	0
10	Oct. 22, 1913	+0 30	P.	2	4	0
11	Oct. 2, 1914	+0 10	M.	3	5	0
12	Oct. 23, 1914	0 15	P.	2	2	1
13	Oct. 31, 1914	0 3	P.	3	5	1
14	Nov. 2, 1914	−0 2	P.	3	4	1

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.8	−4.65	+1.012	−2.005	.008	S.
2	.9	4.28	0.787	2.020	.012	S.
3	.7	4.24	0.743	2.015	.007	M.
4	.5	−0.71	+0.868	1.950	.002	Mt.
5	.7	0.68	.840	1.950	.002	M.
6	.6	0.64	.800	1.949	.002	S.
7	.5	.063	.789	1.952	.001	S.
8	.7	+0.19	−0.469	1.934	.010	M.
9	.9	0.26	.570	1.946	.002	S.
10	.6	0.43	.780	1.949	.007	M.
11	.7	+3.88	−0.524	1.888	.001	M.
12	.7	4.09	.787	1.878	.007	M.
13	.7	4.17	.862	1.886	.003	P.
14	.8	4.19	.878	1.895	.012	M.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
1	+164.877	− 20.757	0.20	0.58		
4	−171.266	+ 43.319	0.15	0.42		
5	149.515	111.263	0.23	0.48		
6	226.238	23.694	0.12	0.39		
9	+131.509	− 68.904	0.14	0.54		
10	250.632	88.614	0.16	0.52		
π	2.317	+ 7.401		0.64		

Normal equations:

$$96.084\mu + 0.407c - 19.804\pi = + 0.620.$$
$$+9.808 + 0.402 = -19.072.$$
$$+ 5.906 = - 1.064.$$

Solution:

$$\mu = +0''.074 \pm 0''.004.$$
$$c = -1 .945.$$
$$\pi = +0''.023 \pm 0''.016.$$

p. e. unit weight $= \pm 0''.021$.

B. D. + 24° 4463. κ Pegasi = β989. ($21^h 40^m.1$, + 25° 11′.)
Mag. 5.0 − 5.1. $\mu = +0^s.0024$; $+0''.002$. Spectrum F_5.

The measures were in longitude. This is a very close binary with a period of 11.37 years. The combined images of its components were not elongated.

Flint found the parallax of this star to be + 0″.02. Russell computed a hypothetical parallax of + 0″.043.

Table 1.

No.	Date	Hour angle	Observer	No. of expo-sures	Quality of images	No. of inter-polations
		hr. min.				
1	July 8, 1912	+0 12	B.	2	2	0
2	July 16, 1912	0 0	M.	3	4	1
3	Oct. 5, 1912	+0 25	M.	3	2	0
4	Oct. 6, 1912	0 15	M.	3	3	0
5	Oct. 16, 1912	0 30	B.	2	1	0
6	Oct. 30, 1912	0 42	B.	3	2	1
7	July 3, 1913	+0 18	B.	3	1	0
8	July 8, 1913	0 30	B.	3	2	0
9	Sept. 28, 1913	+0 19	M.	3	3	0
10	Nov. 1, 1913	0 40	M.	3	4	0
11	July 19, 1914	+1 10	S.	3	5	0
12	July 28, 1914	1 35	S.	3	5	0

Table 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.7	−2.95	+0.790	+1.020	.005	M.
2	.7	2.87	.699	1.005	.009	S.
3	.8	−2.06	−0.569	0.990	.007	M.
4	.7	2.05	.583	0.999	.002	M.
5	.6	1.95	.712	0.992	.003	S.
6	.7	1.81	.855	1.004	.010	S.
7	.7	+0.65	+0.843	+1.028	.000	S.
8	.8	0.70	.793	1.038	.011	S.
9	.7	+1.52	−0.464	1.007	.004	M.
10	.7	1.86	.870	1.008	.002	S.
11	.9	+4.46	+0.667	1.037	.001	M.
12	.9	1.55	.544	1.036	.001	M.

COMPARISON STARS.

No.	X	Y	Depend-ence	Diameter	B. D. No.	Mag-nitude
4	−115.240	+184.709	0.17	+0.53	+24° 4460	8.8
5	127.407	1.598	0.18	0.58	24° 4458	9.0
7	200.322	− 66.342	0.17	0.39		
10	+206.999	194.842	0.24	0.67		
11	235.972	+ 74.877	0.24	0.35		
π	30.719	− 7.614		0.75		

Normal equations:

$$64.074\mu+1.899c+4.765\pi=2.216.$$
$$+8.908\ \ +0.535\ \ =9.038.$$
$$+4.443\ \ =0.627.$$

Solution:

$$\mu=+0''.016\pm0''.002.$$
$$c=+1\ .013.$$
$$\pi=+0''.073\pm0''.009.$$

p. e. unit weight $\pm0''.018$.

B. D. $+24° 4533$. ι Pegasi. ($22^h 2^m.4$, $+24° 51'$.)
Mag. 3.96. $\mu = +0^s.0220; +0''.018$. Spectrum F_5.

The measures were made in longitude. The star is a spectroscopic binary. No other parallax of this star has been published.

TABLE 1.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interferometer
		hr. min.				
1	Oct. 19, 1914	−0 9	P.	3	2	1
2	Nov. 16, 1914	0 10	P.	3	3	0
3	Nov. 18, 1914	+0 18	P.	3	5	1
4	June 28, 1915	+0 4	Ma.	3	5	0
5	July 5, 1915	0 5	Ma.	3	3	1
6	July 6, 1915	0 15	M.	3	5	0
7	July 8, 1915	0 5	M.	3	4	0
8	July 14, 1915	−0 43	Ma.	3	5	0
9	July 17, 1915	+0 0	M.	3	4	0
10	Oct. 30, 1915	+1 6	Ma.	2	3	0
11	Nov. 6, 1915	0 40	Ma.	2	4	1
12	Nov. 7, 1915	0 33	S.	3	4	1

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.7	−2.31	−0.674	−0.110	.017	M.
2	.7	2.03	.933	.135	.010	M.
3	.8	2.01	.943	.133	.008	M.
4	.7	+0.21	+0.932	.052	.004	M.
5	.9	0.28	.879	.048	.006	M.
6	.9	0.29	.870	.057	.003	M.
7	.9	0.31	.853	.069	.014	M.
8	1.0	0.37	.793	.047	.007	M.
9	.9	0.40	.760	.058	.004	M.
10	.7	+1.45	−0.796	.049	.005	M.
11	.7	1.52	.861	.049	.004	M.
12	.9	1.53	.869	.058	.005	M.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
4	−147.588	+ 65.622	0.246	0.52	+24° 4529	8.7
7	230.907	− 26.866	0.210	0.43		
8	+177.581	166.886	0.231	0.79	24° 4536	8.3
13	200.915	+128.128	0.313	0.34		
π	19.052	12.199		0.55		

Normal equations:

$$9.800c + 0.479\mu + 0.650\pi = -0.689.$$
$$+15.593 \quad +2.401 \quad = +0.311.$$
$$+7.068 \quad = +0.096.$$

Solution:

$$\mu = +0''.094 \pm 0''.007.$$
$$c = -0\ .072.$$
$$\pi = +0''.063 \pm 0''.011.$$

p. e. unit weight $\pm 0''.027$.

B. D. $+56^\circ 2741$. ϵ Cephei. ($22^h 11^m.3$, $+56^\circ 33'$.)
Mag. 4.23. $\mu = +0^s.0544; +0''.044$. Spectrum A_5.

The measures were made in longitude. This star has a large proper motion. Two other determinations of its parallax have been published. They are:

By Smith (Heliometer), who obtained $+0''.100$.

By Slocum and Mitchell (Photography), who obtained $+0''.060$.

Table 1.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Oct. 5, 1913	−0 10	M.	3	3	2
2	Nov. 3, 1913	0 5	S.	3	5	0
3	Nov. 2, 1914	+0 7	P.	3	3	0
4	Nov. 16, 1914	0 15	P.	3	3	0
5	July 5, 1915	+0 36	Ma.	2	5	0
6	July 8, 1915	0 20	M.	2	4	0
7	July 14, 1915	0 0	Ma.	3	5	0
8	July 17, 1915	0 20	M.	3	5	0
9	July 22, 1915	−0 7	P.	3	5	0
10	July 23, 1915	+0 5	Ma.	3	5	1
11	Nov. 20, 1915	+0 27	Ma.	2	4	0
12	Dec. 4, 1915	0 28	Ma.	2	4	1

Table 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.8	−5.24	−0.406	−0.038	.004	M.
2	.9	4.95	.790	.037	.001	M.
3	.7	−1.31	−0.776	.052	.008	M.
4	.7	1.17	.900	.068	.006	M.
5	.6	+1.14	+0.921	.126	.009	M.
6	.7	1.17	.898	.127	.009	M.
7	1.0	1.23	.845	.139	.003	M.
8	1.0	1.26	.815	.144	.007	M.
9	.9	1.31	.762	.146	.008	M.
10	.9	1.32	.751	.136	.003	M.
11	.8	+2.52	−0.925	.161	.002	M.
12	.7	2.66	.979	.162	,001	M.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
2	+221.098	−100.854	0.167	0.33	+56° 2748	9.5
7	− 9.102	+116.327	0.161	0.37	56° 2745	9.4
8	75.658	107.052	0.185	0.46	56° 2738	8.8
10	191.611	74.434	0.233	0.30		
12	+ 55.273	−196.957	0.254	0.42	56° 2740	9.3
π	− 8.999	11.031		0.45		

Normal equations:

$$9.700c - 0.145\mu + 0.570\pi = 0.964.$$
$$+64.162 \quad +8.205 \quad = 1.723.$$
$$+6.520 \quad = 0.314.$$

Solution:

$$\mu = +0''.123 \pm 0''.003.$$
$$c = +0\ .099.$$
$$\pi = +0''.030 \pm 0''.008.$$

p. e. unit weight $\pm 0''.019$.

B. D. + 74° 1006. π Cephei. ($23^h 4^m.7$, + 74° 51′.)
Mag. 4.56. $\mu = + 0^s.0030; - 0''.025$. Spectrum G_5.

The measures are in right ascension. This is a binary of long period. The combined image of the two images did not appear elongated and was bisected in making the measures. No other parallax of this star has been published.

TABLE I.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	Oct. 19, 1914	+0 0	M.	3	1	1
2	Nov. 18, 1914	−0 3	P.	3	5	0
3	July 14, 1915	+0 2	Ma.	2	4	0
4	July 17, 1915	0 20	M.	2	5	0
5	July 22, 1915	−0 22	P.	3	4	0
6	July 23, 1915	+0 0	Ma.	3	4	0
7	July 24, 1915	0 6	M.	3	4	0
8	Oct. 24, 1915	+0 45	M.	3	3	0
9	Oct. 29, 1915	0 34	M.	2	2	0
10	Nov. 7, 1915	−0 25	S.	3	4	0
11	Nov. 27, 1915	+0 26	Ma.	3	4	0
12	Nov. 28, 1915	−0 25	S.	3	4	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.5	−2.78	−0.61	−0.072	−.002	P.
2	.9	2.48	.86	.067	.001	P.
3	1.0	−0.10	+0.75	.078	.012	P.
4	.5	.07	0.72	.059	.007	P.
5	.6	.02	0.67	.062	.004	P.
6	1.0	.01	0.66	.069	.003	P.
7	.5	.00	0.65	.045	.021	P.
8	.6	+0.92	−0.65	.046	.011	P.
9	.9	.97	.70	.062	.006	P.
10	1.0	1.06	.79	0.60	.004	P.
11	1.0	1.26	.90	0.48	.006	
12	.6	1.27	.90	0.60	.006	P.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
2	+161.058	−162.988	+0.255	0.66	+74° 1010	9.5
4	−213.488	+ 42.090	.281	0.69	74° 1000	9.1
6	79.802	105.798	.242	0.66	74° 1003	9.3
10	+132.232	15.100	.222	0.50		
π	− 8.944	− 0.698		1.11		

Normal equations:

$$9.100c + 0.728\mu - 1.832\pi = -0.561.$$
$$14.446 \quad -0.975 \quad = +0.012.$$
$$5.204 \quad = +0.089.$$

Solution:

$$\mu = +0''.017 \pm 0''.007.$$
$$c = -0\ .063.$$
$$\pi = -0''.020 \pm 0''.012.$$

p. e. unit weight $\pm 0''.026$.

B. D. + 56° 2966. Bradley 3077. ($23^h\ 8^m.5$, + 56° 37′.)
Mag. 5.65. $\mu = + 0^s.2522; + 0''.296$. Spectrum K.

The measures were in longitude. This star has a large proper motion. Brunnow, Blacklund, Gylden, Peters, and Flint have published parallaxes of this star. They found it, respectively, to be + 0″.070, + 0″.20, + 0″.28, + 0″.13, and + 0″.35. Adams found a hypothetical parallax for it of + 0″.17.

TABLE 1.

No.	Date	Hour angle	Observer	No. of expo-sures	Quality of images	No. of inter-polations
		hr. min.				
1	July 16, 1912	+0 0	M.	3	2	4
2	July 26, 1912	0 0	B.	2	2	0
3	July 30, 1912	−0 18	B.	3	2	3
4	Oct. 5, 1912	0 20	M.	2	5	0
5	Oct. 16, 1912	−0 6	B.	1	4	0
6	Oct. 20, 1912	0 25	M.	3	3	0
7	Nov. 19, 1912	+0 0	M.	3	4	1
8	July 8, 1913	+0 30	B.	2	5	0
9	July 11, 1913	−0 35	S.	3	4	1
10	Oct. 5, 1913	0 15	M.	3	3	0
11	Oct. 16, 1913	−0 14	M.	3	5	0
12	Nov. 1, 1913	+0 15	M.	3	5	2
13	Nov. 4, 1913	−0 15	M.	3	4	2
14	Aug. 13, 1914	+0 30	P.	2	4	0
15	Aug. 16, 1914	0 30	P.	2	1	1

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.7	−3.00	+1.016	−0.261	.002	S.
2	.7	2.90	0.995	.247	.002	S.
3	.6	2.86	.979	.248	.004	M.
4	.6	2.19	.171	.203	.005	S.
5	.5	−2.08	−0.018	.201	.008	S.
6	.7	2.04	.086	.183	.008	M.
7	.7	1.74	.566	.179	.004	S.
8	.7	+0.57	+1.011	+0.146	.006	M.
9	.9	0.60	1.015	.165	.010	M.
10	.7	1.46	0.175	.220	.002	S.
11	.7	+1.57	−0.013	.236	.009	S.
12	.8	1.73	.285	.236	.001	S.
13	.6	1.76	.334	.236	.001	S.
14	.7	+4.58	+0.892	.606	.002	P.
15	.8	4.61	.866	.607	.004	P.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
2	+109.451	+ 74.243	0.20	0.58		
6	− 47.972	165.201	0.18	0.68		
8	81.336	161.904	0.17	0.56		
9	167.544	− 63.150	0.12	0.74		
11	+122.059	103.443	0.18	0.75	+56° 2970	9.1
13	65.343	234.753	0.15	0.57		
π	11.315	+ 10.637		0.78		

Normal equations:

$$67.189\mu + 1.368c + 1.286\pi = 7.848.$$
$$+10.508 \quad +4.201 \quad = 0.813.$$
$$+5.226 \quad = 0.547.$$

Solution:

$$\mu = +0''.540 \pm 0''.002.$$
$$c = +0\ .047.$$
$$\pi = +0''.181 \pm 0''.009.$$

p. e. unit weight $\pm 0''.017$.

B. D. + 26° 4734. 85 Pegasi = β 733. $23^h 56^m.8$, + 26° 34′.0
Mag. 5.85. μ = + $0^s.0622; -0''.986$. Spectrum G.

The measures were made in longitude. This is a binary of 26.3 years. The faint component did not affect the image of the brighter one. Brunnow, Flint, Chase, Slocum, and Mitchell have published parallaxes of this star. They are, respectively, $+0''.054$, $+0''.03$, $+0''.10$, and $+0.''084$. Adams and Russell give hypothetical parallaxes for this star of $+0''.10$ and $+0''.071$ respectively.

TABLE 1.

No.	Date	Hour angle	Observer	No. of exposures	Quality of images	No. of interpolations
		hr. min.				
1	July 22, 1912	+0 36	B.	2	4	1
2	July 30, 1912	−0 18	B.	2	4	0
3	Nov. 18, 1912	−0 24	B.	3	5	0
4	Nov. 19, 1912	+0 0	M.	3	4	1
5	Oct. 15, 1913	+0 12	P.	3	2	0
6	Oct. 16, 1913	0 17	M.	3	5	1
7	Oct. 22, 1913	0 17	P.	3	5	0
8	Nov. 22, 1913	1 0	M.	3	4	0
9	Dec. 11, 1913	−0 10	M.	3	4	0
10	July 19, 1914	−0 8	S.	2	5	0
11	July 28, 1914	+0 20	S.	3	4	0
12	July 29, 1914	−0 15	S.	3	5	0
13	July 31, 1914	+0 35	M.	3	4	1
14	Aug. 15, 1914	1 0	P.	3	5	0
15	Aug. 16, 1914	0 36	P.	2	2	0
16	Aug. 21, 1914	0 46	P.	3	4	0

TABLE 2.

No.	Weight of plate (p)	Time in 100 days (T)	Parallax factor (P)	Solution (m)	Residual (v)	Measured by
1	.8	−4.88	+0.961	+1.912	.005	P.
2	.8	4.80	.908	1.924	.008	P.
3	.7	−3.69	−0.700	1.910	.004	P.
4	.9	3.68	.712	1.897	.010	P.
5	.9	−0.38	−0.189	1.984	.005	H.
6	.9	0.37	.206	1.993	.004	P.
7	.9	0.31	.306	1.992	.005	P.
8	.8	0.00	.647	1.982	.005	P.
9	.9	+0.19	.914	1.991	.006	P.
10	.7	+2.39	+0.979	2.078	.004	P.
11	1.0	2.48	.926	2.070	.005	H.
12	.5	2.49	.914	2.081	.006	P.
13	.7	2.51	.904	2.067	.008	M.
14	.9	2.66	.760	2.073	.001	H.
15	.8	2.67	.748	2.085	.010	P.
16	1.0	2.72	.688	2.070	.005	P.

COMPARISON STARS.

No.	X	Y	Dependence	Diameter	B. D. No.	Magnitude
1	− 9.427	+166.808	0.25	0.44		
2	117.716	172.553	0.25	0.40	+26° 4732	9.5
5	166.681	−211.761	0.24	0.42		
8	+293.822	127.601	0.26	0.44		
π	6.594	+ 0.396		0.72		

Normal equations:

$$96.685\mu - 0.014c + 8.957\pi = 2.254.$$
$$+13.205 \quad +3.068 = 26.483.$$
$$+7.402 = 6.491.$$

Solution:

$$\mu = +0''.101 \pm 0''.002.$$
$$c = +2\ .001.$$
$$\pi = +0''.101 \pm 0''.008.$$

p. e. unit weight $\pm 0''.019$.